MT-95000
MT-96000
Operations Manual

Astro-Med, Inc.®

MT-95000/MT-96000 Operations Manual

Astro-Med, Inc.
Part Number
22834-197

Serial Number _____

Issued to _____

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Congratulations. Your Astro-Med purchase is an investment in the finest of state-of-the-art recorder technology. The information provided below lists the model number, serial number, and software version of your chart recorder. Verify that the software configuration number (SCN) that appears on the display of your chart recorder after it has been powered-up exactly matches the software version given below. The software version recorded below is the most current software version available for your chart recorder. As noted below, the software version number represents the software as originally installed in your instrument. Any upgrades of the chart recorder's resident software should be noted in the space provided. If, for any reason, it should be necessary for you to contact Astro-Med regarding your purchase, please refer to the following:

Model Number:_____

Serial Number:_____

Software Version:_____
(original installation)

Upgraded Software Version:_____
(date installed: ___/___/___)

Upgraded Software Version:_____
(date installed: ___/___/___)

Upgraded Software Version:_____
(date installed: ___/___/___)

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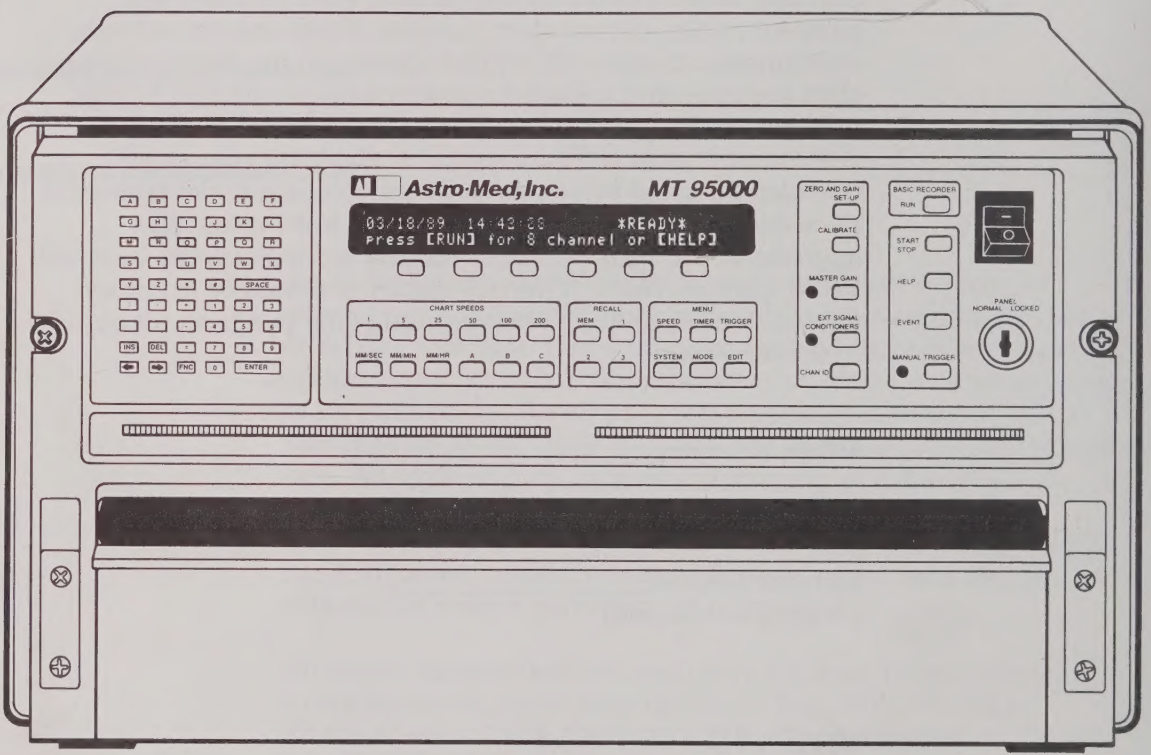

Astro-Med MT-95000 Chart Recorder

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So, You Don't Like to Read Manuals

Both the MT-95000 and MT-96000 are remarkably friendly and versatile chart recorders. The Operations manual tells you in detail how to exploit the full range of the recorder's capabilities. We certainly encourage you to read and refer to the combined MT-95000/MT-96000 documentation package.

But for those of you who just like to get things started, the following paragraphs briefly introduce some of the chart recorder's "at your finger tip" controls.

Turn the Recorder On

Both chart recorders display a series of messages during their power-up sequences. Watch the chart recorder (in this case an MT-95000) when it displays this message:

(The MT-96000 will display a similar message.) Notice that the chart recorder performs an automatic gain self-calibration procedure. The self-calibration procedure tests and corrects the baseline offset for each range and channel.

- any waveform output is interrupted briefly
- the calibration process is performed
- the chart is annotated with the ground reference and calibration factor for each channel
- the interrupted recording resumes

The procedure is extremely accurate. In fact, its precision is traceable to the requirements of the United States National Institute of Standards and Technology.

Press the BASIC RECORDER RUN Key

The MT-95000/MT-96000 will immediately begin real-time recording. If your chart recorder is equipped with eight channels, it will enter 8-channel real-time recording. If your recorder is equipped with twelve channels, it will enter 12-channel real-time recording. A sixteen channel chart recorder will begin to record in 16-channel format.

Press the START / STOP Key

Recording will halt and resume as the key is pressed. When you don't need hardcopy, you can halt printing and save chart paper.

Press the HELP Key

The chart recorder (in this case an MT-95000) shows the following display:

If you press the soft key beneath HELP, the chart recorder will immediately print-out a QUICK START GUIDE TO OPERATION. This guide highlights the use of many of the chart recorder's important operational capabilities.

If you press the soft key beneath KEYS you'll get an immediate print-out of a GENERAL KEYPAD INFORMATION page. This provides a simplified drawing of the chart recorder's front panel controls and information on their functions and uses.

Pressing the soft key beneath STAT invokes the menu used to specify print-out of the status of current system setup parameters or the parameters of any of the three system setups stored in the RECALL Group's MEM keys.

Press the EVENT Key While Recording

Notice how the chart recorder's left event marker deflects to the left when the key is pressed.

The left event marker is the straight line printing nearly at the left edge of the chart paper.

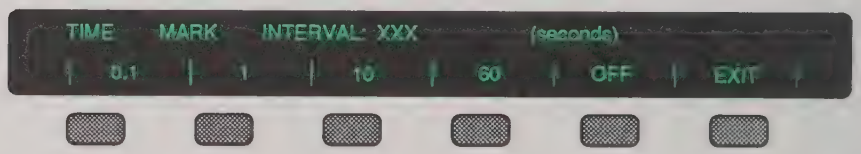
The marker stops deflecting and returns to printing as a straight line when the key is released. Use the EVENT key when you want to mark data of interest.

Press the CHAN ID Key While Recording

The number of each channel is printed near each channel's center. If you change the order of the channels, this is a really useful feature. In overlap recording, the channel number is printed right on the waveform. You'll never be in doubt about waveform ID when working in any overlap mode.

Press the TIMER Key While Recording

In the case of an MT-95000, you'll get this menu:



Press the soft key beneath any of the timing mark intervals and notice that a timing mark is being printed along the right system event marker at the time interval you selected. The timing mark appears as a black "tick."

Press Any of the CHART SPEEDS Keys While Recording

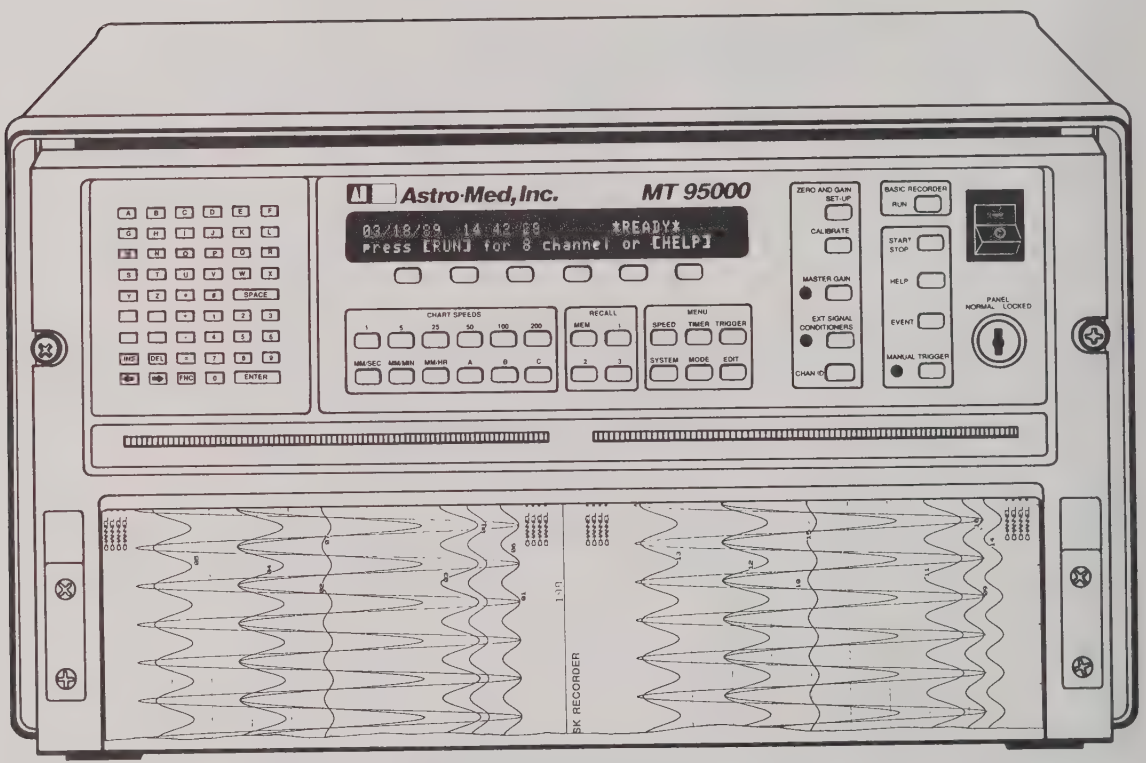
The chart paper speed immediately changes to the selected speed.

Press Either the (A), (B), or (C) Keys While Recording

The chart paper speed will change to the default speed of the insta-speed key. After you've programmed these keys, you'll have three customized speed keys at your disposal.

And So Much More

That's enough for now but there is much more to know about operating your chart recorder. Please take the time to familiarize yourself with the full Operations manual. It will really introduce you to the power of the MT-95000/MT-96000.


Astro-Med, Inc.
MT 95000
03/18/89 14:42:09 *READY*
press [RUN] for 8 channel or [HELP]
CHART SPEEDS
RECALL
MENU
ZERO AND GAIN SET-UP
CALIBRATE
MASTER GAIN
EXT SIGNAL CONDITIONERS
CHAN ID
BASIC RECORDER
RUN
START STOP
HELP
EVENT
MANUAL TRIGGER
PANEL NORMAL LOCKED
8K RECORDER

Section 1 Introduction

1-1 About This Manual

The purpose of this manual is to provide you with all the information required to operate your Astro-Med Multi-Task (MT)-95000 chart recorder or MT-96000 chart recorder as a stand-alone instrument. For the sake of simplicity, the examples and displays provided throughout this manual are based on the actions of an MT-95000. Control of your chart recorder through a remote host computer is discussed in the MT-95000/MT-96000 Host Control Operations Manual. Maintenance of your chart recorder is detailed in the MT-95000/MT-96000 Maintenance and Service Manual.

This manual discusses all of the functions, features, and capabilities of your chart recorder. Separate sections of the manual discuss recorder installation, operation, and theory of operation.

1-2 Recorder Highlights

The MT-95000 and MT-96000 introduce the "MT-95000 Series." Astro-Med's innovative New Technology chart recorders integrate thermal printing, programmable memory, proprietary software, and solid state design to achieve unprecedented versatility and reliability. The inks, toners, mechanical styluses, and adjustments associated with older technology recorders have been eliminated. Consequently, routine maintenance and calibration requirements have been dramatically reduced.

A Commitment to Quality

Completely designed and built in the United States, the MT-95000 and MT-96000 are backed by Astro-Med's two-year warranty on both parts and labor.

The MT-95000 and MT-96000 continue Astro-Med's commitment to the development of the MT Series: a new generation of programmable, thermal-printing chart recorders. The 8-channel versions of these recorders can be expanded in increments of four-channels to either 12 or 16 channels. Each channel has a separate text buffer, event marker, and analog-to-digital (A/D) converter. The recorder prints a System Log along the left edge of the chart. Invented by Astro-Med, the System Log automatically notes the exact time and date, the current time scale in ms/mm, and the current recording mode. Digitally processing incoming data with 12-bit accuracy, the chart recorder can simultaneously create any of several possible grids while printing waveforms directly onto Z-fold thermal-paper packs or thermal paper rolls. Printing the waveforms and grid at the same time results in total correlation between the recorded waveforms and the selected grid. Data skew is simply eliminated.

Unmatched Chart Clarity

The charts produced by the MT-95000 and MT-96000 have laser-printer resolution along the amplitude axis: 300 dots-per-inch. This allows full 42.4 mm channels to be ruled with 50 divisions per channel. The time axis provides even greater resolution. As a result, waveforms are recorded with none of the digitizing effects of lower-resolution printouts. The recordings produced by the MT-95000 and MT-96000 are always smooth, clear, and accurate.

A crystal-referenced stepper motor drive system advances the chart paper through the recorder. Chart speed integers from 1 through 200 can be selected in time ranges of mm/hour, /minute, or /second. In addition, a maximum chart paper speed of 500 mm/s can be selected.

Viewing of recorded data is virtually immediate; a factor of critical importance in real-time chart recorders. There are no mechanical delays or delays associated with image-development. The chart recorder's dual thermal printheads are located very close to the recorder's front and are are unobscured by anti-static brushes or cowlings. The printing elements of each printhead are "near edge." This means that they are in close proximity to the printhead's edge and the recorder's front. In addition, a row of internal lights illuminates the printheads and eliminates shadows on the chart paper as it leaves the recorder.

A bank of LED indicators (a "light bar") is located immediately above each printhead. The LED bars have the 20 kHz frequency response of the recorder. Using the same data as the printheads, the LED bars generate a dynamic view of waveform activity. At chart speeds below 100 mm/sec, the bars are active even when the input signal is not being being recorded. Clearly visible at a distance, the bars provide a convenient mechanism for monitoring waveform activity.

At 42.4-mm wide with 50 ruled divisions, the channels printed during 8-channel recording are the widest available in any chart recorder.

Whether the chart recorder is an 8-, 12-, or 16-channel system, the order of the channels on the chart can be changed instantly with a few front-panel keystrokes. No cable rearrangement of any kind is required.

Simple keystrokes permit immediate changes in recording format from separate channels to overlapped channels. When formats are changed, grid design automatically alters but grid calibration is retained.

When the front-panel ID pushbutton is pressed, waveforms are immediately labelled with their respective channel designations. This makes the identification of overlapped waveforms obvious and is useful in determining the order of separate channels that may have been rearranged.

Unexcelled Frequency Response and Accuracy

The MT-95000 and MT-96000 have the unexcelled real-time frequency response range of DC to 20 kHz. Frequency response is maintained without distortion, without reduction in amplitude, and without phase shift regardless of the selected sample rate.

The chart recorder accepts signals from 0.5 to 40 volts full-scale and contains eight built-in, programmable signal conditioners. Gain and zero positioning are fully programmable. The front-panel CAL pushbutton causes the gain range and zero position of each channel to be printed directly onto the chart. An RS-232 D-shell connector and a GPIB (IEEE-488) D-shell connector are provided to connect the chart recorder to a host computer. BNC connectors are also provided for signal input. The signal conditioners "talk", i.e., they automatically report their gain and position settings in the channel's annotation buffer. Generally, the last forty character spaces of the buffer are used for this purpose.

In addition to its built-in signal conditioners, up to sixteen Astro-Med ASC-900 signal conditioners can be used externally with the chart recorder in Astro-Med's C-950 signal conditioner card cage. When the front-panel EXT SIGNAL CONDITIONERS pushbutton is pressed, the recorder is automatically calibrated to the output of the external signal conditioners (0.5V) and the ASC-900 settings are reported in the last forty character spaces of each channel's annotation buffer.

The chart recorder has the extraordinary ability to calibrate itself on demand with a precision traceable to the requirements of the United States National Institute of Standards and Technology.

When the recorder's CALIBRATE key is pressed,

- each channel input is grounded.
- each baseline is labelled.
- an extremely precise reference voltage is input and labelled.
- internal adjustments are made as necessary to exactly maintain the original zero and position selections.

Easy to Use Front Panel Features

Knobs and dials are completely absent from the chart recorder's front panel controls. Instead, the front panel puts a well organized and convenient array of soft-touch pushbutton controls at your disposal. For convenience, the recorder's pushbutton controls are refered to as keys throughout this manual.

A generous alphanumeric keypad is provided for editing the instrument's 120-character annotation buffers. The keypad contains the full alphabet, numeric keys 0 through 9, punctuation and symbol keys, insert and delete keys, left and right arrow keys, function key, and enter key.

A bright vacuum fluorescent display provides two 40-character rows of highly visible menu selections and data entry readouts.

The chart recorder's front panel is equipped with many powerful keys providing rapid access to the recorder's most important programmable features. These are highlighted below.

The **BASIC RECORDER RUN** key causes the recorder to immediately enter basic real-time recording in 8, 12, or 16 individual channels (depending upon the configuration of your chart recorder).

The **RECALL** keys provide three programmable keys each of which stores a complete system setup that can be implemented with a keystroke.

The **HELP** key results in a menu through which any of three HELP or STATUS sheets can be immediately printed. These help sheets are: a Quick Start Guide to Operation, General Keypad Information, and a Status Report that can provide full system status information on either the active system setup or any of three user-defined, recallable system setups.

The **CHART SPEED** keys provide instant access to six preset speed increments and three time ranges. A, B, C keys can be programmed to chart speeds of your choice.

The **MENU** keys provide direct access to some of the recorder's most important menu setup parameters: SYSTEM, MODE, EDIT, TRIGGER, TIMER, and SPEED.

The **EVENT** key causes the system event marker to deflect to the left to mark data of interest.

The **MANUAL TRIGGER** key allows data-capture snapshots or dual speed recording to be triggered from the front panel.

ZERO AND GAIN SETUP, CALIBRATE, MASTER GAIN keys provide adjustment controls for the recorder's built-in signal conditioners. **EXT. SIGNAL CONDITIONERS** key permits the use of Astro-Med's ASC-900 signal conditioners and the C950 signal conditioner card cage. The MASTER GAIN and EXT SIGNAL CONDITIONERS keys have LED indicators that light when their keys are invoked.

The **START / STOP** key provides a direct control that either halts recording or resumes recording.

The Front Panel Lock "freezes" the current settings of the front panel controls when the key is inserted and turned to the LOCKED position.

Host Control and More

RS-232 and IEEE-488 ports on the recorder's rear panel provide the connections that enable a host computer to control most chart recorder activities.

The extraordinary real-time recording performance of the MT-95000 and MT-96000 can be powerfully complemented with the recorder's Data Capture option (DC-950).

Real-time recording and data capture and playback recording are briefly described below. Section 3, "Operation," fully discusses each of the chart recorder's controls and modes.

1-3 Real-Time Recording Modes

The chart recorder has five real-time recording modes.

Continuous Real-Time Recording

Standard 8 channels of analog waveform data. Expandable in 4-channel increments to 12 or 16 channels.

Timed Recording

Recording begins and ends at the dates and times that you specifically programmed.

Timed Dual Speed Recording

Recording toggles between two user-programmed or default recording speeds at time intervals that you program or at default intervals.

Triggered Dual Speed Recording

When a user-programmed trigger is sensed, recording toggles between two programmed or default recording speeds at time intervals that you specify.

Datalogger Recording

Waveform data is scaled and recorded as columns of user-defined engineering units.

1-4 Data Capture and Playback Modes

Data capture and playback require the installation of the Data Capture option (DC-950)

The chart recorder has nine individually selectable sample rates: 1, 5, 10, 20, 25, 40, 50, 100, and 200 kHz per channel. This allows you to choose the sample rate that is most appropriate for your data. In most cases, sampling data at a rate approximately 10 times faster than than the highest waveform frequency provides excellent playback resolution.

Each recording channel has a data capture memory of 128 kilosamples (128k). An eight-channel system has 1 megaByte of data capture memory. A twelve-channel system, has 1.5 megaBytes of data capture memory. A sixteen-channel system has 2 megaBytes of data capture memory.

In an eight-channel system, you can sample either 8 channels or 2 channels. In a twelve-channel system, you can sample either 12 channels or 3 channels. In a sixteen-channel system, you can sample either 16 channels or 4 channels.

The chart recorder has the exceptional ability to perform data capture snapshots without interrupting ongoing real-time recording. This is referred to as "background data capture." Captured data is held until you specify a playback format and start the playback.

Captured data can be replayed in any real-time recording format: as separate channels, as overlapped waveforms, in datalogger format,or as an X-Y plot. The playback is labelled with time and date of capture, sample rate, time scale and effective chart speed, trigger channel and location, and more.

Using the TRIGGER menu, you can select the amount of pretrigger data desired in the playback in 1% increments. This means that the playback can consist of up to 100% pretrigger data.

Any percentage of the data snapshot can be replayed in any available format any number of times. In addition, the time scale resolution and effective chart speed of the playout can be expanded or compressed by factors of: x1, x2, x4, x8, ÷2, ÷4.

1-5 Additional Modes

Three additional modes complement the recorder capabilities available in the Real-Time Modes and the Data Capture and Playback Modes.

Line or page printing

When operating under host control, accepts data for printing by line or page.

Bitmapped Graphic Printing

Graphic printing for applications.

Formfeed

Advances chart paper to next top-of-form index mark.

1-6 Chart Recorder Configurations

The chart recorder is generally furnished in one of the configurations described on the following page. Naturally, you are not limited to chosing from the recorder configurations described. Astro-Med will be delighted to assemble a custom configuration to fit your exact recording needs. Any combination of recorders, signal conditioners, and cases can be ordered.

When this manual refers to the "MT-95000" or "MT-96000," it is referring to the generic chart recorder and not to any particular recorder configuration.

1-6 Chart Recorder Configurations (continued)

MT-95000R

Rack-mounting. The recorder is provided with the rack slides and mounting hardware required for installation in standard 19-inch rack-mount cabinets. No recorder case is provided with this model.

MT-95000

Cased. The recorder is installed in a protective, portable bench-top case.

MT-95000C

Cased with card cage. The recorder and a companion C-950R signal conditioner card cage are provided in a configuration specifically designed to integrate both units in a single protective bench-top case.

MT-96000C

Medical applications. The recorder equipped to meet the particular requirements of the medical environment.

Table 1-1.
Standard Features of the MT-95000/MT-96000

- Eight 50-division channels
- DC to 20 kHz bandwidth
- 300 dot/inch printhead resolution
- Overlap Modes

  four grids each containing two overlapped waveforms
  two grids each containing four overlapped waveforms
- Alphanumeric printing

  eight text buffers each with 120 character spaces
- Datalogger Mode

  scale each channel's waveform data for printing in numeric columns of user-selected engineering units
- Remote Start / Stop

  permits external start/stop of recorder from TTL-low or switch closure
- 500 mm/second chart speed
- A minimum of eight separate A/D converters, 200 kHz/channel real-time sample rate, front panel gain selection from 0.5 to 40V full scale, host programmable

Table 1-1.
Standard Features of the MT-95000/MT-96000 (continued)

- Two system event markers
- System Log reporting time, date, chart speed, time scale, and 30 user-programmable characters
- Dual Speed Mode causes recorder to alternate between two speeds based on trigger or time
- Self-printing HELP sheets that summarize recorder features and operations
- ID pushbutton to identify waveform channel; especially useful during overlap recording
- GPIB (IEEE-488) multi-user interface
- RS-232C serial computer interface
- Three programmable insta-speeds
- Three programmable system setups
- Start-up kit with 500 sheet pack of Z-fold chart paper
- Operations, Maintenance, and Host Control Manuals
- AC power cord
- Free IBM PC compatible floppy disk with OP-95000 demonstration software

Table 1-2.
Physical / Functional Specifications

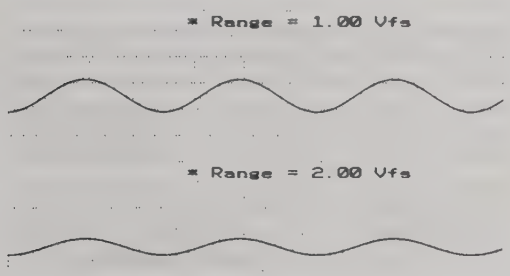
Dimensions	Bench version: 20" (50.8cm) wide x11-1/2" (29.2cm) high x 18-1/2" (47 cm) deep Rack-mount version: 19" (48.3 cm) wide x 10-1/2" (26.7 cm) x 17-1/2" (44.5 cm) deep
Weight	49 pounds (22.25 kg)
Power Requirements	Line: 110/240 VAC 48 - 440 Hz 600 watts maximum Fuse: 120 V, 6 amps (250 V) 240 V, 3 amps (250 V)
Recording Method	Direct-writing. Resolution: 300 dots/inch (12 dots/mm)
Paper	Low-cost, permanent, black-imaging thermal paper
Paper Width	16.3 inches (415 mm)
Paper Length	Z-Fold Pack: 500 sheets (458 ft/140 m), individually numbered in descending order Roll: 500 foot (Rewinder accessory required)

Table 1-2.
Physical / Functional Specifications (continued)

Number of Channels	Analog Waveform: 8 standard 12 or 16 optional Digitized Waveforms (DI-488 or DI-16-950 option required): 8, 12, or 16
Event Markers	Two standard: • one actuated by front panel control, TTL low, switch closure, or host control command • one actuated by internal timer switch, TTL low, switch closure, or host control command (Up to 16 additional event markers can be added with the EM-950 option. Actuated by TTL low, switch closure, or host control command.)
Interchannel Annotation	standard: 8 text buffers each containing 120 character spaces optional: 12 or 16 text buffers with 12 and 16 channel systems ASCII characters entered via front panel keypad. Complete ASCII character set can be entered via host computer.

Table 1-2.
Physical / Functional Specifications (continued)

"Talking" Signal Conditioner Annotation	Gain and zero position settings automatically printed in the last 40 character spaces of the interchannel text buffers When used with external ASC-900 Series signal conditioners in the C950R card cage, ASC-900 Gain and zero position settings automatically printed in the last 40 character spaces of the interchannel text buffers. Reporting for each channel can be separately turned on or off



System Log Printing	Time, date, chart speed, time scale, recording mode, and 30 user-addressable characters printed in a "System Log" along the left edge of the chart paper

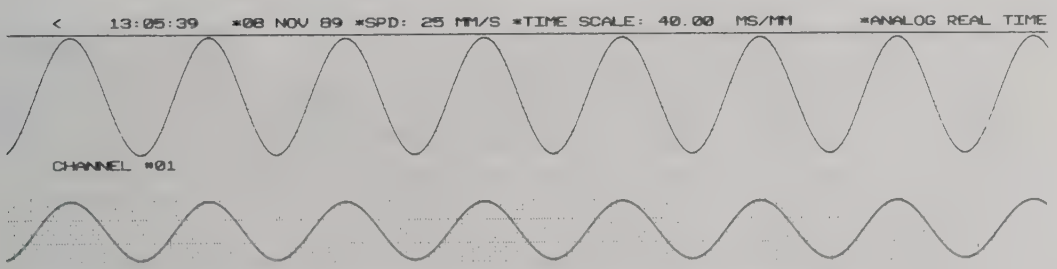


Table 1-2.
Physical / Functional Specifications (continued)

Other Printing	Line Printer: 80 columns x 66 rows, left half of page, 750 characters/second Page Printer: two 80-column x 66 row pages 1500 characters/second Rotated Line Printer: 130 columns x 120 lines (reads parallel to paper travel) ID pushbutton: each waveform labeled with appropriate channel number
Real-Time Sample Rate	200 kHz per channel
Real-Time Bandwidth	dc to 15 kHz, <0.5 dB dc to 20 kHz, <2 dB dc to 25 kHz, <3 dB
Resolution	12 bits per channel
Chart Visibility	1/4-inch from printhead dots to waveform visibility Illuminated viewing area Built-in LED light arrays provide continuous real-time presentation of waveforms when chart is running to 100 mm/sec or with chart stopped

Table 1-2.
Physical / Functional Specifications (continued)

Chart Type	Z-fold pack, 500 sheets per pack (11" per sheet) Roll, 500 feet long requires rewinder accessory (RW-950)
Chart Dimensions	16.3" wide 458' long (Z-fold) 500' long (roll)
Grid Printing	Simultaneous with waveform. Eliminates data skew.
Grid Selections	10 major divisions 50 minor divisions on/off MT-96000: special grids for medical applications Grid printing on/off
8-Channel System Format	• Eight separate 42.4mm-wide grids each containing an individual waveform • Four 85 mm-wide grids each containing two overlapped waveforms • Two 170 mm-wide grids each containing four overlapped waveforms
12-Channel System Format (optional)	• all 8-channel format capabilities plus: • Twelve 21 mm-wide grids each containing an individual waveform • Two 170 mm-wide grids each containing six overlapped waveforms • four grids each containing three overlapped waveforms

Table 1-2.
Physical / Functional Specifications (continued)

16-Channel System Format (optional)	• all 8- and 12-channel system format capabilities plus: • Sixteen 21 mm-wide grids each containing an individual waveform • Two 170 mm-wide grids each containing eight overlapped waveforms • Four grids each containing four overlapped waveforms
Real-Time Recording Modes	Continuous real-time recording Dual Speed recording based on time Dual Speed recording based on trigger level Timed Operation: start and stop at programmed times Formfeed: advance chart paper to next top-of-form index mark
Data Capture Modes (DC-950 option required)	Instant Capture and Replay playback in selected replay mode (any format available in real-time recording) manual or automatic rearming of trigger Background Capture and Delayed Replay performs capture and retains in memory for later replay; real time recording continues without interruption

Table 1-2.
Physical / Functional Specifications (continued)

Data Capture RAM (optional)	128 kilosamples total memory per channel 1 megasample in an 8-channel system. 1.5 megasamples in a 12-channel system. 2 megasamples in 16-channel system
Pre-Trigger Selections	Start, Center, End, or selectable from 0 to 100% in 1% steps
Best Time Scale Resolution	12.5 µs/mm effective chart speed: 80 meters/second with expansion Time scale resolution, effective chart speed, expansion and compression factors automatically printed on chart.
Expansion / Compression Factors	x1, x2, x4, x8, ÷2, ÷4
Trigger Identification	Event marker on right edge of chart indicates trigger location within the replayed data
Data Capture Sample Rates	Selectable from: 1, 5, 10, 20, 25, 40, 50, 100, 200 kHz per channel
Data Capture Quantization	12 bit

Table 1-2.
Physical / Functional Specifications (continued)

Background Data Capture	Real-time recording continues uninterrupted during data capture
Event Markers	If desired, event markers may be captured and replayed with snapshots
Additional Modes	Line or page printing Datalogger Operation: eight columns of user-scalable engineering units Bit map graphic printing
A/D Converters	1 per channel
Analog Inputs	Four BNC's per A/D board end plate On 8-channel systems, one 25 pin D-shell connector on end plate of CHAN 1-8 A/D board On 12- and 16-channel systems, one 25 pin D-shell connector on end plate of CHAN 1-8 A/D board and one on end plate of CHAN 9-16 end plate Input type: floating common ground between channels Front panel selectable gain settings from 0.5 to 40 volts full scale; many fine and coarse programmable adjustments Input impedance: >1 MegOhm

Table 1-2.
Physical / Functional Specifications (continued)

Computer Interfaces	RS-232C Serial Interface front-panel selectable baud rate: 300, 1200, 2400, 4800, 9600, and 19200; also includes XON/XOFF and DTR/DSR capabilities IEEE-488 (GPIB) Multi-User Parallel Interface address selections from 0 to 30
Chart Speeds from Keypad	1 mm/hr to 500 mm/sec Every integer from 1 through 200 selectable in mm/hr, mm/min, mm/sec time ranges. Also selectable, 500 mm/sec.
Chart Speed from Discrete Keys	• six integer selections: 1, 5, 25, 50, 100, and 200 • other speeds available through alphanumeric keypad • range keys: mm/sec, mm/min, mm/hr • programmable A, B, C insta-speed keys
Recall Section	[MEM], [1], [2], [3] keys invoke three preprogrammed and complete system setups

Table 1-2.
Physical / Functional Specifications (continued)

Menu Section	[SPEED] key accesses the menu to specify any desired chart speed
	[TIMER] key accesses the menu to select the timing mark interval
	[TRIGGER] key accesses the menu to specify all trigger condition parameters
	[SYSTEM] key accesses the menu to specify all system setups, e. g., channel order, IRIG type, time, date, etc.
	[MODE] key accesses the menu to select the operating mode
	[EDIT] key accesses the menu to edit the interchannel text buffers
Channel Section	[ZERO AND GAIN SET-UP] key accesses the menu for specifying gain and zero positions of all channels
	[CALIBRATE] key causes precise, automatic calibration signals to be sent to each channel. Prints gain and zero settings on the chart.
	Calibration signal traceable to requirements of the U.S. National Institute of Standards and Technology (formerly NBS)
	[MASTER GAIN] key change the gain setting of each channel to the gain setting of channel 1. Associated LED indicates when [MASTER GAIN] is invoked.

Table 1-2.
Physical / Functional Specifications (continued)

Channel Section (cont.)	[EXT SIGNAL CONDITIONERS] key calibrates the recorder to receive input from external ASC-900 Series signal conditioners. Associated LED indicates when [EXT SIGNAL CONDITIONERS] is invoked. [CHAN ID] key causes immediate printing of appropriate channel number on each waveform
Operation Section	[BASIC RECORDER RUN] key immediately initiates recording in either the 8-channel mode, 12-channel mode, or 16-channel mode (depending upon the configuration of your chart recorder) [START STOP] stops or re-initiates ongoing printing [HELP] key results in a menu through which any of three HELP or STATUS sheets can be invoked and immediately printed. These help sheets are: Quick Start Guide to Operation, General Keypad Information, and a Status Report that provides full system status information on either the active system setup or any of three user-defined, recallable system setups [EVENT] key causes event marker to deflect to the left to mark data of interest. Marker returns to the right when key is released.

Table 1-2.
Physical / Functional Specifications (continued)

Operation Section (cont.)	[MANUAL TRIGGER] key provides a front-panel mechanism for manually triggering a data capture snapshot or dual speed recording. Associated LED indicates when a valid trigger occurs.
Front Panel Lock	Disables all front-panel keys to prevent alteration of current recorder settings
Motor Type	Micro-stepped, crystal referenced stepper motor
Power On / Off Switch	Toggles between applying and removing power from the recorder

1-7 Options

The versatility of the MT-95000/MT-96000 chart recorder can be enhanced by the addition of any of a variety of optional features. Table 1-3 is a complete list of options available for the recorder.

Table 1-3.
Options for the MT-95000/MT-96000 Recorder

DC-950	Data Capture Provides eight channels of high speed data capture and slow motion playback of waveform data. Provides: • sample rates from 1 kHz to 200 kHz per channel • 1 megasample memory buffer in 8-channel system • 1.5 megasample memory buffer in 12-channel system • 2 megasample memory buffer in 16-channel system • for each A/D board, capture all channels or a single channel • 1% - 99% pretriggering • event marker capture • capture can occur in background leaving real-time recording uninterrupted
EM-95	Event Marker Provides 8 event markers that can be actuated through a TTL low or switch closure. Input is through a 9-Pin D-shell connector on each A/D board. Four event markers are provided by each A/D board.

Table 1-3.
Options for the MT-95000/MT-96000 Recorder (continued)

IR-950	IRIG Time Decoder Enables recorder to accept modulated or demodulated IRIG A, B, H, or NASA 36 time codes and prints text within System Log. Generates a precise on-time pulse for the standard event marker.
RD-950	Remote Drive Allows external control over chart motor stepping via TTL source. Maximum 800 Hz (50 mm/sec)
AD-400	Analog Channel Expansion Expands existing system by four channels and four 120-character interchannel text buffers. Expands 8-channel systems to 12-channel systems. Expands 12-channel systems to 16-channel systems.
DC-400	Data Capture Expansion Provides four channels of data capture. Can only be installed with AD-400 expansion boards.
EM-400	Event Marker Expansion Provides four event markers. Can only be installed with AD-400 expansion boards.

1-8 Accessories

The MT-95000/MT-96000 is supported by a variety of functional, durable, and attractive hardware accessories. With the equipment discussed below, you can adapt your instrument to the specific requirements of your recording environment. Please consult the individual user manuals that are supplied with Astro-Med signal conditioners and signal-conditioner card cages for information regarding the use of these products with the MT-95000/ MT-96000 recorder.

Rewinder (RW-950)

The Rewinder (RW-950 option) automatically winds chart paper and maintains proper paper-tension as the paper exits the recorder. The rewinder mounts directly to the underside of the recorder. The attached recorder and rewinder can be used with or without bench or rack enclosures.

The rewinder is 21 1/4-inches deep, 17 1/2-inches wide (mounts in a standard 19" rack), and 5 1/4-inches high. The take-up reel of the rewinder accepts a maximum of 500 feet of chart paper. Power is supplied to the accessory through a 115-volt line connection. An on/off pushbutton is located on the lower-left front corner of the rewinder. The on/off pushbutton illuminates when depressed. The rewinder's constant-torque motor applies a constant tension to the chart paper. The motor is compatible with all recorder speeds.

1-8 Accessories (continued)

Roll-Around Cart (RC-95)

The RC-95 option is a heavy duty, moveable cart with 5" caster wheels. It is equipped with drawers and is designed to hold the MT-95000/MT-96000 recorder in its bench-top case. The drawers can either be used for storage or for paper take-up.

Paper Take-Up Drawer (PT-200)

Designed for use with any of Astro-Med's rack-mounted recorder configurations, the Paper Take-Up Drawer (PT-200 option) is used to collect and store thermal Z-fold chart paper as it is discharged from the recorder. The drawer is 19-inches wide, 5 3/16-inches high, and 17-inches deep. The accessory is provided with the slides, screws, and nuts required for attachment to a variety of 19-inch racks. When in use, the drawer opens to 12 inches to catch and store the exiting Z-fold chart paper.

Travel Case (AN-950)

The AN-950 option is a rugged carrying case designed for Common Carrier transportation of the MT-95000/MT-96000 in the recorder's uncased configuration. The travel case is 24-inches long, 21-inches wide, and 15-inches high. The top and bottom of the case are hinged at the rear. When closed, the case is secured with two front latch mechanisms. All exterior corners and seams of the case are reinforced with heavy-gauge aluminum sheathing. The case can be lifted or positioned using any of five handles. One handle is located on the front of the case. The right and left sides of the case each feature two adjacent handles. All interior surfaces of the AN-950 are lined with two inches of cushioning foam custom fitted to the profile of the recorder.

1-8 Accessories (continued)

Rack Enclosures

To satisfy the diverse requirements of our customers' many recorder/peripheral equipment configurations, Astro-Med offers a varied line of rack enclosures. From the 79.7-inch tall FME-10 to the 62.3-inch tall FME-5, Astro-Med rack enclosures can accommodate virtually any equipment combination. Astro-Med installs all internal rack-hardware as required by the equipment choices of the specific customer order. Please contact us with regard to your particular enclosure requirements and we will be happy to suggest the enclosure that may best suit your needs.

Stylus Sound Emulator (SS-95)

The Stylus Sound Emulator generates an audible sound in consonance with the amplitude and frequency of the waveform. This alerts an operator to the presences of a signal.

1-9 Digital Interfaces and Software

Several interfaces are available that enable the MT-95000/ MT-96000 to accept input of digitized waveforms. In addition, several demonstration software packages are available. Table 1-4 lists and briefly describes these resources.

Table 1-4.
Digital Interfaces and Software

DI-488-950	Digital Interface Permits input of either 8, 12, or 16 digitized waveforms via the recorder's IEEE-488 port. Modes included: • Synchronized Digital Data Recording • Synchronized Digital Data recording with Motor Control Packet • Unsynchronized Digital Data Recording
DI-16-950	Digital Interface Permits input of sixteen 16-bit digitized waveforms via the 16 bit parallel port. This is compatible with the VAX parallel board. Your system may require additional hardware/software.
OP-95000	Demonstration Software For use with the IBM PC AT via the recorder's RS-232 or IEEE-488 ports. Provided on 5 1/2" floppy disk. Basic Language, uncompiled. Provided free with the Operations Manual.
OP-VAX	Demonstration Software For use with the DEC VAX 11/785 via the recorder's IEEE-488port. Provided on 1/2" tape at 1600 bpi. Fortran. VAX requires National Instruments GPIB card.

Section 2 Installation

2-1 Initial Setup

Whether your Astro-Med chart recorder is to be rack mounted or installed in a bench-top cabinet, the recorder requires minimal setup. If you have ordered a rack-mount or bench-top cabinet configuration of the chart recorder, note that the recorder is packaged separately from its enclosure. Initial setup information is provided on page 2-2 in "The Initial Setup Process." Installing your recorder in a rack or cabinet is straightforward and is fully described throughout the remainder of this Section.

Before operating your MT-95000 or MT-96000 make sure that you perform the following initial actions.

- Examine the chart recorder's condition and verify that no obvious shipping damage has occurred.

- Verify that the chart recorder is set to the line voltage that you need — either 115 VAC or 230 VAC. The appropriate voltage has been factory-set to your requirements and should not need immediate adjustment.

  To check the line voltage setting, examine the rear-panel voltage selection switch located next to the rear-panel power-entry module.

- If you do want to change the recorder's line voltage, you will need to reconfigure the chart recorder's fuses as described in "Changing the Fuse Block Arrangement" on page 2-6.

The Initial Setup Process

1 After your recorder has been examined, connect the AC power cord:

- first to the rear-panel power input receptacle (lower left corner of the rear panel as you view it)
- then to a power outlet.
- Power Requirements

Line	Fuse
110/240 VAC 48 - 440 Hz 600 watts maximum	120 V, 6 amps (250 V) 240 V, 3 amps (250 V)

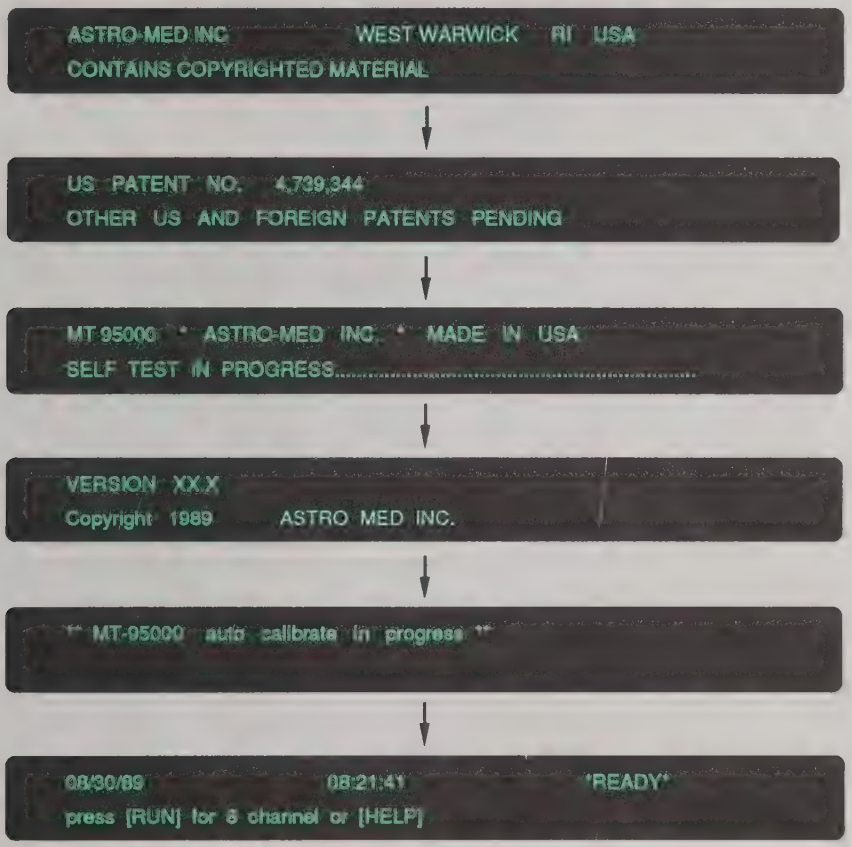
2 Load the recorder with the pack of Astro-Med Z-fold thermal paper.

Open the paper-chamber door and insert the chart paper. Put the paper pack into the paper chamber with the "THIS SIDE UP AND IN FIRST" stamp pointing to the rear of the recorder. Feed the top sheet of paper into the slot beneath the drive roller and gently push the paper through until it exits above the drive roller. Close the paper-chamber door.

(A much more detailed description of this procedure is given Section 3 on pages 3-25 through 3-29, "Loading Z-Fold Thermal Paper.")

3 Push the POWER switch to the "on" position.

The chart recorder will perform a series of self-tests during which the front-panel display will automatically proceed through the following series of displays.


ASTRO-MED INC WEST WARWICK RI USA
CONTAINS COPYRIGHTED MATERIAL
US PATENT NO. 4,739,344
OTHER US AND FOREIGN PATENTS PENDING
MT-95000 * ASTRO-MED INC. * MADE IN USA
SELF TEST IN PROGRESS.....
VERSION XX.X
Copyright 1989 ASTRO MED INC.
** MT-95000 auto calibrate in progress **
08/30/89 08:21:41 'READY'
press [RUN] for 8 channel or [HELP]

If you want to test the the waveform recording capabilities of your chart recorder, you can do so now. The simplest way to accomplish this is to use BNC cables to connect one or more signal sources to the rear-panel A/D board analog-input BNC connectors.

See your signal conditioner manual for detailed information regarding signal conditioner/recorder connections.

Recorder Base Display

At the end of the power-up sequence, the chart recorder's display shows the following message. This message will remain displayed until the recorder's setup or mode keys are used to invoke subsequent menu displays.

For convenience throughout this manual, we will refer to this display as the chart recorder's base display. Note that this display informs you of the current date, the current time, and the recorder's READY status. The display also lets you know that you can immediately begin 8-channel real-time recording simply by pressing the front-panel RUN key. In addition, the display reminds you that the front-panel HELP key provides you with immediate sources for concise operating instructions and system status data.

As described in section 3, "Operation," many of the recorder's menus offer EXIT options that return the recorder to the base display. Be aware that all references to the base display indicate the above display.

Error Codes During Recorder Power-Up

During the recorder's self-test sequence, error codes may appear on the front-panel display. These potential "error codes on wake-up" are shown in table 2-1.

Table 2-1.
Error Codes on Recorder Wake-Up

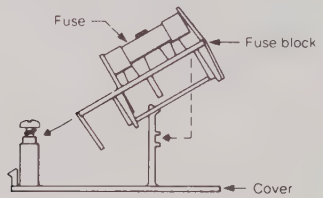
Error Code	Description
	absence of any display on power-up
10	CPU — I/O link error
11	I/O error — RAM error
12	I/O error — interrupt error
15	Keypad error
21	CPU error — RAM error
22	CPU error — GPIB error
23	CPU error — Comm error
24	CPU error — Interrupt error
30	A/D error — invalid configuration
40	Printer error — link error
41	Printer error — RAM error
42	Printer error — Peripheral error
43	Printer error — Printhead
50	Printer error — link error
51	Printer error — RAM error
52	Printer error — Peripheral
53	Printer error — Printhead
61	Light bar error — link error
62	Light bar error — RAM error
80	Paper out or door open
90	Voltage error

Changing the Fuse Block Arrangement

If you want to change the factory-set fuse block arrangement, use the following North American and European fuse setup procedures.

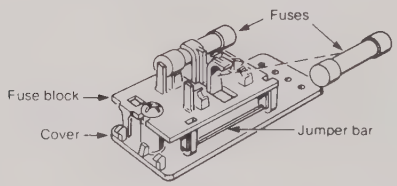
1 Using a small-blade screwdriver, remove the fuse block.The fuse block is on the recorder's rear panel next to the power input receptacle.

2 Loosen the screw that attaches the fuse block to the cover of the fuse block compartment. Slide the fuse block upward and pull it away to release it from the screw and pedestal.



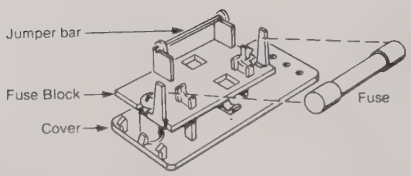
remove fuse block

3 Change the fuse arrangement to the configuration of your choice as shown. Slide the fuse block back onto the screw shaft and pedestal. Tighten the screw. Reinsert the rearranged fuse block.



two
5 mm x 20 mm, 1 Amp, 250 V fuses

European (240 VAC)



one
1/4" x 1-1/4", 2 Amp, 250 V fuse

North American (120 VAC)

Changing the Operating Voltage

Use the rear-panel voltage selection switch to select the operating voltage you desire: either 115V or 230V. The voltage is stamped on the switch.

2-2 Installation Alternatives

Astro-Med provides a complete line of chart recorder accessories and recorder enclosures. The instructions below discuss mounting your chart recorder in an Astro-Med enclosure or in an enclosure that you provide. Attaching the the Rewinder accessory (RW-950) to the recorder is explained. Installing the attached recorder/ rewinder combination in an enclosure is detailed. Attaching the recorder's writing table is also explained.

Astro-Med Rack Mount and Case Enclosures

Astro-Med recognizes that its recorders are used in many different recording environments and in many different equipment configurations. In response, Astro-Med offers a varied line of enclosures to accommodate the MT-95000/MT-96000 and its accessories. Astro-Med rack-mount and case enclosures offer protection, durability, and color-coordinated good looks.
In addition, Astro-Med enclosures offer the time-and-labor saving advantage of being preconfigured for the installation of the recorder and its accessories. Rack-mount enclosures contain AC power strips to ensure that the recorder and its peripheral equipment have easy access to power connections. The cumbersome work of installing interior racks is expertly performed in our factory. Astro-Med also offers customized rack configurations for unique recording requirements.

Recorder Without Case

Operation of the chart recorder does not require a case or rack. When you have setup the recorder, all you have to do is ensure that it is on a stable surface. You can then use the chart recorder's full range of installed features.

Recorder in an Astro-Med Enclosure

After you have unpacked and set-up your chart recorder, disconnect any power cords or signal connection cords before installing the recorder in an Astro-Med enclosure or any other enclosure. Reconnect the recorder after you've completed the installation process.

If you have purchased an Astro-Med rack-mount or case enclosure, it has already been equipped with properly positioned and installed rack assemblies. Follow the procedure below to install the recorder in an Astro-Med enclosure.

WARNING

The recorder is heavy. It is recommended that two individuals perform the lifting and positioning of the recorder required during installation. Never use the rear-panel connections to help in lifting the instrument. The connections cannot support the recorder's weight and, consequently, they will be damaged.

1. Facing the recorder's front panel, grasp both sides of the recorder at the lip formed by the recorder's sides and top.

2. Position the rails mounted to the recorder's sides to mate with the inner rack assemblies already installed in your enclosure.

3 Slide the recorder onto the inner rack assembly mount and carefully push the unit onto the rack assembly until the recorder is fully seated in the enclosure.

CAUTION

Never force the recorder into the enclosure. You may damage both the enclosure and the recorder if you attempt to force the recorder into position. If you encounter resistance when sliding the recorder into place, remove the instrument from the enclosure and try again. When properly mated with the enclosure's rack assemblies, the recorder will slide easily into position.

4 Using the two 2-1/2-inch Phillips-head screws, two nylon washers, and two U-nuts that are supplied with your recorder, secure the recorder in the enclosure.

You will find the screw holes necessary for securing the recorder approximately 3 inches from each of the corners of the recorder's front panel.

5 Establish power and signal input connections to the recorder.

Power is applied to the recorder in a number of ways depending on the particular rack or case being used. To make it easier to connect power and signal inputs, smaller cases may have no back panel. In these instances, connections are made directly to the rear-panel of the enclosed recorder. Larger enclosures may have a lockable rear door that both protects and provides convenient access to the rear of the recorder and its accessories. Larger cases may also have an interior AC power strip allowing the recorder and peripherals to be plugged in within the enclosure itself. You will need to examine your recorder/enclosure configuration to determine how power and signal connections will be established.

Recorder in an Enclosure That You Furnish

If your enclosure has not been supplied by Astro-Med, it may require installation of the rack assemblies supplied with the recorder. Follow the procedure below to install the rack assemblies that support the chart recorder when it is used in any enclosure.

1

Determine where in the enclosure you want to mount the recorder.

Rack-mounting enclosures are equipped with interior frames to which you must attach the rack assemblies needed to hold the recorder. These interior supports have regularly spaced holes along their length to accommodate the mounting screws that will secure the rack assemblies and the recorder in the locations that you choose.

Obviously, where you mount your rack assemblies determines where your recorder will be positioned. As shown in figure 2-1, the recorder is 10-1/2-inches high. A rail is mounted to each side. Running the length of the recorder, the mid-line of each rail is located 6-3/4 inches from the recorder's bottom and 3-1/4 inches from the recorder's top. You need to use these measurements to determine where in the enclosure you want to mount the rack assemblies. Decide where you want the recorder positioned and then either measure down 3-1/4 inches from where the top of the recorder will be or up 6-3/4 inches from where the bottom of the recorder will be.

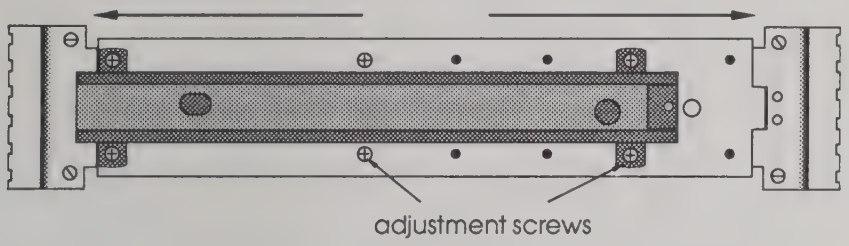
Mark the enclosure's interior frame with a pencil. You have just marked the mid-line of the recorder's rails. Either of these measuring approaches will allow you to position the rack assemblies and, consequently, the recorder in the position you desire.

2

Remove the masking tape that holds the two rack assemblies together and separate them.

3 Loosen the four Phillips-head screws that allow adjustment of the length of the rack assembly. Pull on the rack assembly to lengthen or shorten the assembly to match the depth of your enclosure.

Rack Assembly Adjustment



4 When the rack assembly has been adjusted to the properlength, tighten the four Phillips-head screws to "freeze" the rack assembly at the adjusted length.

5 Attach the front end of one of the rack assembly to either the left or right side (it doesn't matter which) of the enclosure as viewed from the front.

6 Use the two 3/4-inch Phillips-head screws and the bar nut supplied with the rack assembly.

Attach the rear end of the rack assembly to the enclosure in the same fashion.

7 Repeat steps 1 through 6 for the remaining rack assembly assembly.

8 Facing the recorder's front panel, grasp both sides of the recorder at the lip formed by the recorder's sides and top.

WARNING

The recorder is heavy. It is recommended that two individuals perform the lifting and positioning of the recorder required during installation. Never use the rear-panel connections to help in lifting the instrument. The connections cannot support the recorder's weight and, consequently, they will be damaged.

9 Position the rails mounted to the recorder's sides to mate with the inner rack assemblies already installed in your enclosure.

10 Slide the recorder onto the inner rack-slide assembly mount and carefully push the unit onto the rack assemblies until therecorder is fully seated in the enclosure.

CAUTION

Never force the recorder into the enclosure. You may damage both the enclosure and the recorder if you attempt to force the recorder into position. If you encounter resistance when sliding the recorder into place, remove the instrument from the enclosure and try again. When properly mated with the enclosure's rack assemblies, the recorder will slide easily into position.

11 Using the two 2-1/2-inch Phillips-head screws, two nylon washers, and two U-nuts that are supplied with your chart recorder, secure the recorder in the enclosure.

You will find the screw holes necessary for securing the recorder approximately 3 inches from each of the corners of the recorder's front panel.

12 Establish power connections and signal input connections.

Recorder and Rewinder Without Case

If you are using the recorder with the Rewinder option (RW-950), you need to attach the rewinder to the recorder before the MT-95000/MT-96000 is installed in a rack or case. After the components have been attached to one another, they can either be used immediately as a unit or they can be installed as a combination into any suitably configured rack or case.

Use the following procedure to connect a rewinder to your recorder.

1 Facing the recorder's front panel, grasp both sides of the recorder at the lip formed by the recorder's sides and top.

2 Carefully lift the recorder and place it on top of the rewinder.

WARNING

The recorder is heavy. It is recommended that two individuals perform the lifting and positioning of the recorder required during installation. Never use the rear-panel connections to help in lifting the instrument. The connections cannot support the recorder's weight and, consequently, they will be damaged.

3 Position the recorder on the rewinder so that the recorder's preconfigured drill holes are matched to those on each side of the rewinder. You will see that five screw holes in each side of the recorder are the only screw holes available for attachment of the rewinder.

When the recorder is properly positioned, its attaching screw-holes align with those of the rewinder and the take-up reel of the rewinder extends approximately 7.5 inches in front of the recorder's front panel.

4 Attach the recorder to the rewinder using the screws and washers supplied with the rewinder.

- Ten 5/16-inch #6 screws
- Ten flat washers
- Ten split washers

5 Using the power cord supplied with the rewinder, connect the rewinder to any AC power receptacle.

When the rewinder has been attached and loaded with roll thermal paper, the units are ready to be turned on and used.

Recorder and Rewinder In Astro-Med Rack-Mount or Case Enclosure

Follow the directions in "Recorder and Rewinder Without Case." When the recorder and rewinder have been joined, they can be installed in any case or rack configuration that has sufficient space to accommodate them.

If you have purchased an Astro-Med rack-mount or case enclosure, the rack or case has already been equipped with properly positioned and installed rack assemblies. Follow the procedure below to install the recorder/rewinder combination in an Astro-Med enclosure:

1 Facing the recorder's front panel, grasp both sides of the recorder at the lip formed by the recorder's sides and top.

WARNING

The recorder/rewinder is heavy. It is recommended that two individuals perform the lifting and positioning of the recorder/rewinder required during installation. Never use the rear-panel connections to help in lifting the instruments. The connections cannot support the recorder/rewinder's weight and, consequently, they will be damaged.

Recorder and Rewinder In Astro-Med Rack-Mount or Case Enclosure (continued)

2 Position the recorder's slide-mount rails to mate with the inner rail mount already installed in your enclosure.

3 Slide the recorder/rewinder combination onto the inner rail mount and carefully push the units onto the rack assemblies until the units are fully seated in the enclosure.

CAUTION

Never force the recorder/rewinderinto the enclosure. You may damage both the enclosure and the recorder/rewinder if you attempt to force them into position. If you encounter resistance when sliding the recorder into place, remove the instruments from the enclosure and try again. When properly mated with the enclosure's rack assemblies, the recorder/rewinder will slide easily into position.

4 Using the two Phillips-head screws, two nylon washers, and two U-nuts that are supplied with your recorder, secure the recorder/rewinder in the enclosure. The rewinder does not require individual attachment to the enclosure. It is secured because it is attached to the recorder.

You will find the screw holes necessary for securing the chart recorder approximately 3 inches down from each of the top corners of the recorder's front panel.

5 Establish power and signal input connections to the recorder/rewinder.

Recorder and Rewinder In a Rack-Mount or Case Enclosure That You Furnish

Use the following procedure to install the recorder/rewinder combination in an enclosure that you have supplied.

1. Attach the rewinder to the recorder as described in "Recorder and Rewinder without Case."

2. As necessary, install the rack assemblies in your enclosure as described in Recorder in Customer-Rurnished Enclosure.

3. Using the two Phillips-head screws, two nylon washers, and two U-nuts that are supplied with your recorder, secure the recorder/rewinder in the enclosure. The rewinder does not require individual attachment to the enclosure. It is secured because it is attached to the recorder.

   You will find the screw holes necessary for securing the chart recorder approximately 3 inches down from each of the top corners of the recorder's front panel.

4. Establish power and signal input connections to the recorder/rewinder.

Attachment of the Recorder's Writing Table

A writing table is supplied as standard equipment with the recorder. Mounting brackets for the writing table are pre-installed on each side of the paper chamber door. To attach the writing table, simply slip it down onto these brackets.

NOTE

If you use the writing table in conjunction with the recorder/ rewinder combination, you will need to remove the writing table from its support brackets when loading the rewinder with roll thermal paper.

Paper Take-Up Drawer in Astro-Med Enclosure

The Paper Take-Up Drawer (PT-200) is a rack-mounting 5-1/4" deep drawer for collecting thermal Z-fold chart paper as it exits the recorder. If you ordered an Astro-Med enclosure in which the drawer will be used, the rack assemblies that hold the drawer have already been installed. All you need to do is mate the slide rails attached to the drawer with the rack assemblies already installed in the enclosure. Carefully slide the drawer into the enclosure until it is fully seated. When properly seated, the drawer will open and close smoothly.

CAUTION

Never force the drawer into the enclosure. You may damage both the enclosure and the drawer if you attempt to force the drawer into position. If you encounter resistance when sliding the drawer into place, remove it from the enclosure and try again. When properly mated with the enclosure's rack assemblies, the drawer will slide easily into position.

Paper Take-Up Drawer in an Enclosure That You Furnish

If you are mounting the take-up drawer in your own enclosure, you will need to install the rack assemblies supplied with the drawer. The installation procedure for the rack assemblies is identical to the procedure given in "Recorder in an Enclosure That You Furnish." Please refer to that discussion to install your paper take-up drawer.

Section 3 Operation

3-1 General Information

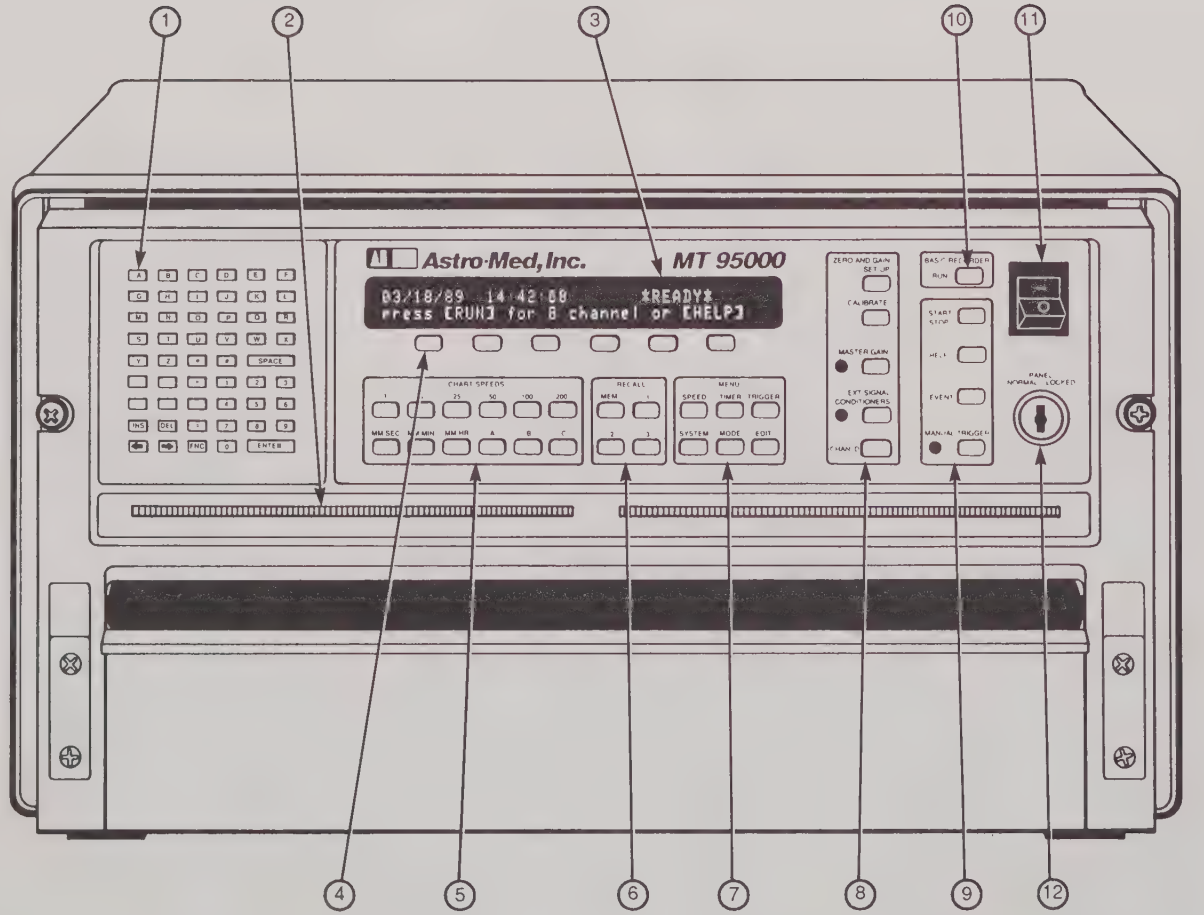
The MT-95000/MT-96000 is factory equipped with Real-Time Operation as a standard capability. All information regarding operation of the recorder's data capture and playback capabilities presupposes that the Data Capture and Playback option (DC950) has been installed in the recorder.

Paragraphs 3-2 and 3-3 discuss the chart recorder's physical controls and features. The remainder of section 3 provides specific information detailing all recorder operations.

3-2 Description of Front Panel Controls

One of the first things to notice about the front panel of the versatile MT-95000/MT-96000 is that control knobs have been completely eliminated. Instead, you control the recorder using convenient "one touch" pushbutton keys. Throughout this manual they will be referred to as simply as "keys."

As shown in figure 3-1, the chart recorder has twelve distinct front panel control features.



1 alphanumeric keypad
2 light bars
3 front panel display
4 soft keys
5 CHART SPEEDS group
6 RECALL group
7 MENU group
8 CHANNEL group
9 Operation group
10 BASIC RECORDER RUN
11 power on/off
12 front panel lock

① Alphanumeric Keypad

The alphanumeric keypad is located on the left side of the front panel. It consists of six columns with nine keys in each column. The keypad contains keys representing the full alphabet, numeric keys 0 (zero) through 9, punctuation and symbol keys, insert and delete keys, left and right arrow keys, function key, and enter key.

② Light Bars

Two horizontal light bars are located just above the paper chamber door. Each bar consists of 74 elements and each is associated with a corresponding printhead. The light bars provide a visual reference indicating the real-time positions of all traces being printed.

③ Front Panel Display

The front panel display is a 7" by 3/4" vacuum fluorescent module located near the center and top of the front panel. The display has two 40-character lines. One line of information is displayed above the other. Each character is formed on a 5 x 7 dot matrix resulting in bright, clear displays of both upper and lower case characters. The full 96-character ASCII set is supported by the display.

④ Soft Keys

Six keys are located immediately beneath the front panel display. Unlike the other controls of the front panel, these keys are not screened with labels identifying their purpose. They are "soft" in the sense that they have a variety of functions rather than a single, fixed purpose. Soft keys are always used when a mode or parameter is being viewed and defined on the recorder's front panel display.

The soft keys are physically below the front panel display because they are always used in correlation with the information shown in the display.

When a system parameter or recording mode is being implemented, it is often necessary to specify data and to chose from alternatives within the parameter or mode. The soft keys are used to select and define menu options.

⑤ CHART SPEEDS Group

The keys of the top row of the CHART SPEEDS group represent six preprogrammed chart speeds.

The [MM/SEC], [MM/MIN], and [MM/HR] keys specify whether the selected chart speed will be in millimeters per second, per minute, or per hour.

The [A], [B], and [C] keys are "insta-speed" keys programmed to the chart paper speeds of your choice.

⑥ RECALL Group

These keys of the RECALL group are extremely powerful. Each of the numbered keys stores a complete system setup that is implemented when the [MEM] [X] keying sequence is pressed.

"System setup" is a concise way of referring to all of the parameters that define any particular recording operation. Any given system setup can include up to approximately fifty recording parameters. You define as many or as few of these parameters as you need to record in the format you desire.

You no longer have to repeatedly reprogram the recorder to reestablish frequently used system setups. Now you can store them in their entirety and recall them with a key stroke.

⑦ MENU Group

The keys of the MENU group include: [SPEED], [TIMER], [TRIGGER], [SYSTEM], [MODE], [EDIT].

These keys give you the flexibility to go directly to specific menus and quickly change the parameters in the menus. MENU keys are frequently used with the recorder's soft keys to define the recorder's operating conditions.

⑧ CHANNEL Group

The keys of the Channel group enable you to define the signal conditioning parameters of the MT-95000's built-in signal conditioners. The individual keys of this group include [ZERO AND GAIN SETUP], [CALIBRATE], [MASTER GAIN], [EXT SIGNAL CONDITIONERS], and [CHANNEL ID].

⑨ Operation Group

The right side of the front panel contains a column of four unrelated "operation" keys: [START/STOP], [HELP], [EVENT], and [MANUAL TRIGGER]. "Operation" here indicates simply that, when pressed, each key results in a specific and immediate recorder operation.

⑩ BASIC RECORDER RUN Key

Depending upon the configuration of your recorder, the BASIC RECORDER RUN key enters the MT-95000/MT-96000 into 8-, 12-, or 16-channel real-time recording.

⑪ Power On/Off Switch

The recorder's electrical power ON/OFF rocker switch is located in the upper right-hand corner of front panel.

⑫ Front Panel Lock

Located below the power ON/OFF switch, the front panel lock is screened PANEL and has two position settings: NORMAL and LOCKED. this switch provides a valuable tool for system security and for the maintenance of current system parameters.

When set to NORMAL, the switch allows full access to the front panel controls. You can alter any of the recorder's settings. When set to LOCKED, the switch locks out the front panel controls and you cannot alter any control settings.

The power ON/OFF switch is not affected by the front panel lock.

3-3 Rear Panel Input/Output Connections

The features of the rear panel of an MT-95000 are illustrated on the following page. A brief description of each feature identified in the figure is provided below.

① Fan Vent

The fan vent is a wire-mesh screened area through which air circulated by the ventilation fan enters the recorder.

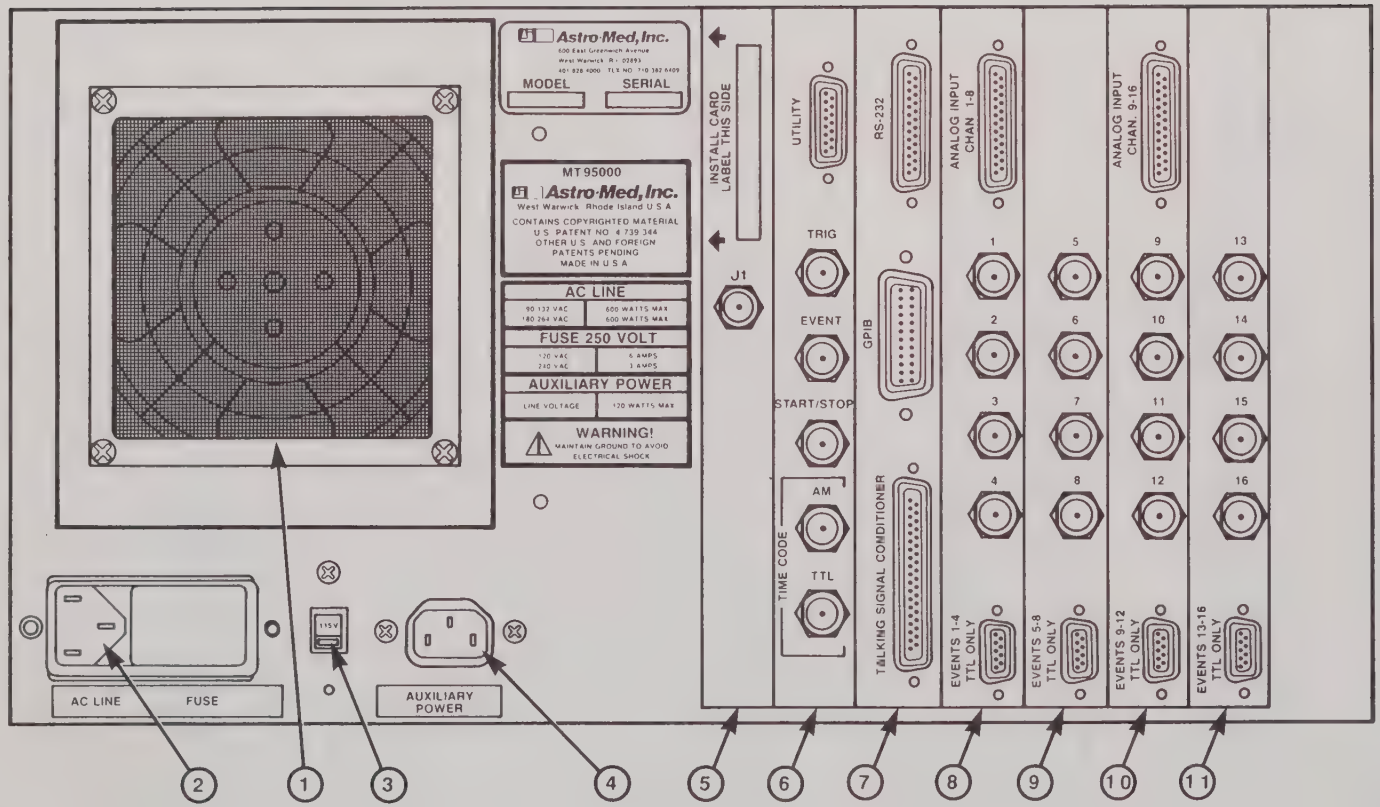
② Power Input Receptacle

The power input receptacle is a male connector consisting of three protruding contacts. The female end of the chart recorder's power cord is pushed onto these contacts and seated. The male end of the power cord is then inserted into an electrical outlet to supply power to the recorder. The power input receptacle is located in the lower left corner of the rear panel. It is labelled "AC LINE."

Power Requirements

Line	Fuse
110/240 VAC 48 - 440 hertz 600 watts maximum	120 V, 6 amps (250 V) 240 V, 3 amps (250 V)

The fuse block is housed next to the power input receptacle. It is labelled "FUSE."



1 fan vent
2 power input receptacle
3 voltage selection switch
4 AUXILIARY POWER receptacle
5 Utility Board End Plate
6 I/O Board End Plate
7 CPU Board End Plate
8 A/D Board 1 End Plate
9 A/D Board 2 End Plate
10 A/D Board 3 End Plate
11 A/D Board 4 End Plate

③ Voltage Selection Switch

The voltage selection switch provides an exceptionally convenient mechanism for setting the recorder's operating voltage.

Setting the switch to its upper position configures the recorder to operate on standard North American voltage: 115 VAC. When this setting is selected you will be able to see "115V" stamped on the switch.

Setting the switch to its lower position configures the recorder to operate on European voltage: 220 VAC. When this setting is selected you will be able to see "220V" stamped on the switch.

④ AUXILIARY POWER Receptacle

The AUXILIARY POWER receptacle is a standard electrical connector (120 W maximum). It can be used to accommodate a card cage power cord.

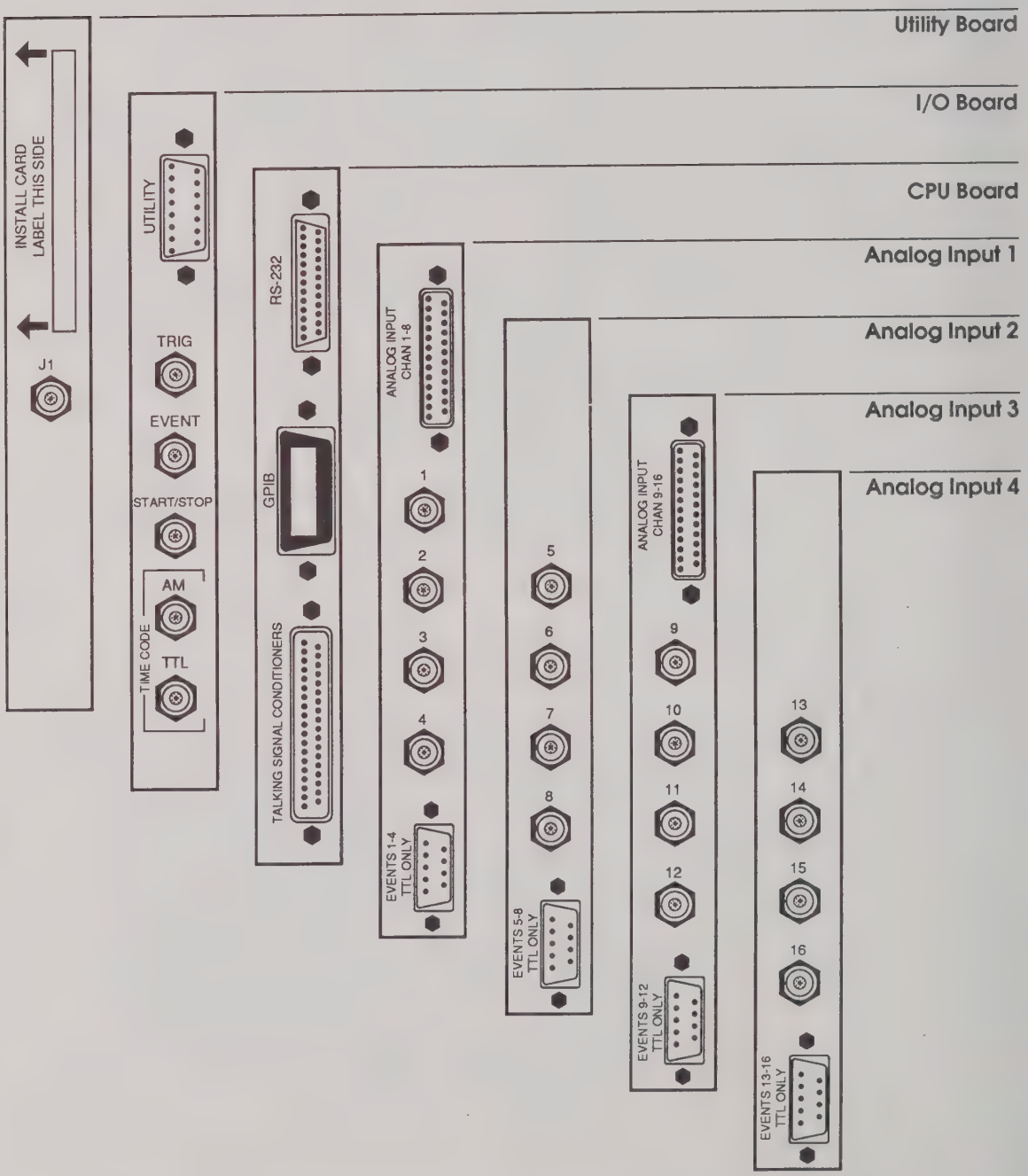
⑤ Utility Board End Plate Connections

The end plate of the Utility Board is the first PC board end plate to the right of the chart recorder's identification and power requirement stickers.

The end plate of the Utility Board has two connections: the software upgrade card insert port and the J1 connector.

The software upgrade card insert port accepts the memory card used to implement upgrades to the chart recorder's operating system software.

The J1 connector is a multipurpose BNC connector.


Utility Board
I/O Board
CPU Board
Analog Input 1
Analog Input 2
Analog Input 3
Analog Input 4
INSTALL CARD
LABEL THIS SIDE
J1
UTILITY
TRIG
EVENT
START/STOP
AM
TTL
TIME CODE
GPIB
RS-232
TALKING SIGNAL CONDITIONERS
ANALOG INPUT
CHAN 1-8
EVENTS 1-4
TTL ONLY
EVENTS 5-8
TTL ONLY
ANALOG INPUT
CHAN 9-16
EVENTS 9-12
TTL ONLY
EVENTS 13-16
TTL ONLY
1
2
3
4
5
6
7
8
9
10
11
12
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14
15
16

⑥ I/O Board End Plate Connections

The end plate of the I/O Board is the second PC board end plate to the right of the recorder's identification and power requirement stickers.

The end plate of the I/O Board has six connections: the UTILITY D-shell connector, the TRIG BNC connector, the EVENT BNC connector, the START/STOP BNC connector, the AM BNC connector, and the TTL BNC connector:

- **UTILITY D-shell connector**

The UTILITY D-shell connector is a multipurpose 15-pin D-shell connector used to communicate various externally generated commands to the recorder.

- **UTILITY D-shell connector pin table**

Description*	Pin #
/System Event Marker 1	1
/System Event Marker 2	2
Remote Start / Stop	3
/External Trigger	4
TTL In	5
AM In	6
reserved for future use	7
external motor speed	8
ground	9
reserved for future use	10
reserved for future use	11
reserved for future use	12
reserved for future use	13
reserved for future use	14
reserved for future use	15

*The symbol "/" indicates a TTL active low.

- **TRIG BNC connector**

The TRIG BNC connector allows you to implement a trigger from an external source through a switch closure or TTL low when the trigger source selection is specified as either (1) external or (2) manual or external. The trigger can be used to initiate either a data capture or dual-speed recording.

- **EVENT BNC connector**

The EVENT BNC connector enables you to mark a system event through an external source when your chart recorder is operating in a real-time mode. The on/off action can be initiated by either a switch closure or TTL low.

- **START / STOP BNC connector**

The START / STOP BNC connector enables you to start or stop recording through an external source. The start/stop action can be initiated by either a switch closure or TTL low.

- **AM BNC connector**

The AM BNC connector allows you to input modulated IRIG A, IRIG B, IRIG H, or NASA 36 time codes into the chart recorder.

- **TTL BNC connector**

The TTL BNC connector allows you to input demodulated IRIG A, IRIG B, IRIG H, or NASA 36 time codes into the chart recorder.

⑦ CPU Board End Plate Connections

The end plate of the CPU Board is the third PC board end plate to the right of the recorder's identification and power requirement stickers.

The end plate of the CPU Board has three connections: the RS-232 D-shell connector, the GPIB D-shell connector, and the TALKING SIGNAL CONDITIONER D-SHELL connector.

- **RS-232 D-shell connector**

The RS-232 receptacle is a 25-pin D-shell connector that is the RS-232 communications interface between the chart recorder and various host-computer configurations. Control of the chart recorder by host computer is documented in the MT-95000/MT-96000 Host-Control Operations Manual. Pin connection data for the RS-232 D-shell connector is provided in the table below.

- **GPIB D-shell connector**

The GPIB D-shell connector is the IEEE communications interface between the chart recorder and various host-computer configurations. Control of the chart recorder by host computer is documented in the MT-95000/MT-96000 Host Control Operations Manual. Pin connection data for the GPIB D-shell connector are provided below.

- **TALKING SIGNAL CONDITIONER D-shell connector**

The signal conditioner reporting interface is a 37-pin D-shell connector used exclusively with a maximum of two Astro-Med C-950 Signal Conditioner Card Cages to provide the recorder with signal conditioner status data. Connection of two card cages is provided for to accommodate 12- and 16-channel recorder configurations. The data transmitted can be printed with the recorder's waveform trace outputs.

- **RS-232 D-shell connector pin table**

Description	Pin #	Source
RXD	2	Host
TXD	3	Recorder
CTS	4	*
RTS	5	*
DTR**	6	Recorder
Common	7	-
Reserved***	10	-
Reserved***	12	-
Reserved***	13	-
Reserved***	14	-
Reserved***	16	-
RS-232 +V†	18	Recorder
DSR**	20	Host
Reserved***	23	-
Reserved***	24	-

8 bits, no parity, 2 stop bits
(Baud rate 300, 1200, 9600, 19.2k)
*Pins 4 and 5 are connected internally.
**DTR is asserted by the chart recorder when the recorder is ready to receive data from the host. DSR must be asserted to assure that no data are lost.
***Reserve pins may have active voltage. Do not use.
†Pin 18 must be tied to Pin 20 for XON/XOFF transmissions. If XON/XOFF is used, Pin 6 (DTR) is not used.

- **GPIB D-shell connector pin table**

Description	Pin #
DIO1	1
DIO2	2
DIO3	3
DIO4	4
EOI	5
DAV	6
NRFD	7
NDAC	8
IFC	9
SRQ	10
ATN	11
SHIELD	12
DIO5	13
DIO6	14
DIO7	15
DIO8	16
REN	17
GROUND (6)	18
GROUND (7)	19
GROUND (8)	20
GROUND (9)	21
GROUND (10)	22
GROUND (11)	23
GROUND LOGIC	24

GROUND (X) = the signal ground return of the referenced contact.

⑧ A/D Board 1 End Plate Connections

The end plate of A/D Board 1 is the fourth PC board end plate to the right of the recorder's identification and power requirement stickers.

The end plate of A/D Board 1 has six connections: the ANALOG INPUT CHAN 1-8 D-shell connector, BNC connectors 1, 2, 3, 4, and the EVENTS 1-4 D-shell connector.

- **ANALOG INPUT CHAN 1-8 D-shell connector**

The ANALOG INPUT CHAN 1-8 D-shell connector is a 25-pin connector that can be used in place of BNC connectors 1-8 to input analog signals into channels 1 through 8. It cannot be used at the same time as BNC connectors 1-4 or 5-8.

- **BNC connectors 1-4**

BNC connectors 1-4 can be used to input analog signals into channel's 1 through 4. These BNC connectors provide an alternative to the ANALOG INPUT D-shell connector. They cannot be used at the same time as the ANALOG INPUT D-shell connector.

- **ANALOG INPUT CHAN 1-8 D-shell connector pin table**

Description	Pin #
Ground	1
Channel 1 analog input	2
Ground	3
Channel 2 analog input	4
Ground	5
Channel 3 analog input	6
Ground	7
Channel 4 analog input	8
Ground	9
Channel 5 analog input	10
Ground	11
Channel 6 analog input	12
Ground	13
Channel 7 analog input	14
Ground	15
Channel 8 analog input	16
Ground	17
reserved for future use	18
reserved for future use	19
reserved for future use	20
reserved for future use	21
Ground	22
Ground	23
Ground	24
Ground	25

- **EVENTS 1-4 D-shell connector**

The EVENTS 1-4 D-shell connector is functional only if your recorder is equipped with the EM-400 event marker option. An EM-400 event marker option is required for each group of four event markers.

The EVENTS 1-4 D-shell connector is a nine-pin connector used to input the TTL signals required to activate the event markers associated with channels 1-4.

- **EVENTS 1-4 D-shell connector pin table**

Description	Pin #
/EVENT 1	1
/EVENT 2	2
/EVENT 3	3
/EVENT 4	4
reserved for future use	5
reserved for future use	6
reserved for future use	7
reserved for future use	8
Ground	9

⑨ A/D Board 2 End Plate Connections

The end plate of A/D Board 2 is the fifth PC board end plate to the right of the recorder's identification and power requirement stickers.

The end plate of A/D Board 2 has five connections: BNC connectors 5, 6, 7, 8 and the EVENTS 5-8 D-shell connector.

- **BNC connectors 5-8**

BNC connectors 5-8 can be used to input analog signals into channel's 5 through 8. These BNC connectors provide an alternative to the ANALOG INPUT D-shell connector on A/D Board 1. They cannot be used at the same time as the ANALOG INPUT D-shell connector on A/D Board 1.

- **EVENTS 5-8 D-shell connector**

The EVENTS 5-8 D-shell connector is functional only if your recorder is equipped with the EM-400 event marker option. An EM-400 event marker option is required for each group of four event markers.

The EVENTS 5-8 D-shell connector is a nine-pin connector used to input the TTL signals required to activate the event markers associated with channels 5-8.

- **EVENTS 5-8 D-shell connector pin table**

Description	Pin #
/EVENT 5	1
/EVENT 6	2
/EVENT 7	3
/EVENT 8	4
reserved for future use	5
reserved for future use	6
reserved for future use	7
reserved for future use	8
Ground	9

⑩ A/D Board 3 End Plate Connections

The end plate of A/D Board 3 is the sixth PC board end plate to the right of the recorder's identification and power requirement stickers.

The end plate of A/D Board 3 has six connections: the ANALOG INPUT CHAN 9-16 D-shell connector, BNC connectors 9, 10, 11, 12, and the EVENTS 9-12 D-shell connector.

- **ANALOG INPUT CHAN 9-16 D-shell connector**

The ANALOG INPUT CHAN 9-16 D-shell connector is a 25-pin connector that can be used in place of BNC connectors 9-12 and 13-16 to input analog signals into channels 9 through 16. It cannot be used at the same time as BNC connectors 9-12 or 13-16.

- **BNC connectors 9-12**

BNC connectors 9-12 can be used to input analog signals into channel's 9 through 12. These BNC connectors provide an alternative to the ANALOG INPUT D-shell connector. They cannot be used at the same time as the ANALOG INPUT D-shell connector.

- **ANALOG INPUT CHAN 9-16 D-shell connector pin table**

Description	Pin #
Ground	1
Channel 9 analog input	2
Ground	3
Channel 10 analog input	4
Ground	5
Channel 11 analog input	6
Ground	7
Channel 12 analog input	8
Ground	9
Channel 13 analog input	10
Ground	11
Channel 14 analog input	12
Ground	13
Channel 15 analog input	14
Ground	15
Channel 16 analog input	16
Ground	17
reserved for future use	18
reserved for future use	19
reserved for future use	20
reserved for future use	21
Ground	22
Ground	23
Ground	24
Ground	25

- **EVENTS 9-12 D-shell connector**

The EVENTS 9-12 D-shell connector is functional only if your recorder is equipped with the EM-400 event marker option. An EM-400 event marker option is required for each group of four event markers.

The EVENTS 9-12 D-shell connector is a nine-pin connector used to input the TTL signals required to activate the event markers associated with channels 9-12.

- **EVENTS 9-12 D-shell connector pin table**

Description	Pin #
/EVENT 9	1
/EVENT 10	2
/EVENT 11	3
/EVENT 12	4
reserved for future use	5
reserved for future use	6
reserved for future use	7
reserved for future use	8
Ground	9

⑪ A/D Board 4 End Plate Connections

The end plate of A/D Board 4 is the seventh PC board end plate to the right of the recorder's identification and power requirement stickers.

The end plate of A/D Board 4 has five connections: BNC connectors 13, 14, 15, 16 and the EVENTS 13-16 D-shell connector.

- **BNC connectors 13-16**

BNC connectors 13-16 can be used to input analog signals into channel's 13 through 16. These BNC connectors provide an alternative to the ANALOG INPUT D-shell connector on A/D Board 3. They cannot be used at the same time as the ANALOG INPUT D-shell connector on A/D Board 3.

- **EVENTS 13-16 D-shell connector**

The EVENTS 13-16 D-shell connector is functional only if your recorder is equipped with the EM-400 event marker option. An EM-400 event marker option is required for each group of four event markers.

The EVENTS 13-16 D-shell connector is a nine-pin connector used to input the TTL signals required to activate the event markers associated with channels 13-16.

- **EVENTS 13-16 D-shell connector pin table**

Description	Pin #
/EVENT 13	1
/EVENT 14	2
/EVENT 15	3
/EVENT 16	4
reserved for future use	5
reserved for future use	6
reserved for future use	7
reserved for future use	8
Ground	9

3-4 Detailed Paper Loading Procedures

Before you begin to use the chart recorder's front panel controls or initiate any recording, it is necessary to load the recorder with thermal paper.

- If you are using the recorder without using a rewinder, you must load the recorder with Astro-Med Z-fold thermal paper.

- If you have attached Astro-Med's rewinder accessory (RW-950) to the recorder, you must load the recorder and rewinder with Astro-Med roll thermal paper.

For reference and convenience, both of these paper loading procedures are illustrated and described in detail on the following pages. After you've loaded either Z-fold or roll thermal a few times, you'll find that paper loading is straightforward and surprisingly easy.

Please note that some thermal papers can leave a residue which will eventually clog the recorder's printheads. Other papers have a coarse texture that can cause excessive printhead wear. Astro-Med chart paper is manufactured by Astro-Med to exacting standards that eliminate these potential problems. For best results, you must use Astro-Med thermal Z-fold chart paper exclusively.

Loading Z-Fold Thermal Paper

1. Remove the Z-fold thermal paper from its box and locate the "THIS SIDE UP AND IN FIRST" stamp at the top of the paper. Note the two directional arrows on the stamp.

   Each sheet of Z-fold chart paper is marked with a black rectangle referred to as the index mark or top-of-form mark. This is used by the recorder to position the paper to a point just below the Z-fold perforation.

2. Take hold of the lip of the paper-chamber door and pull downward until the door is fully open (horizontal to the surface on which the recorder rests).

3. Place the paper into the paper chamber making sure that the stamped directional arrows point to the rear of the paper chamber.

4. Pull the stamped top sheet of the paper pack out of the recorder.

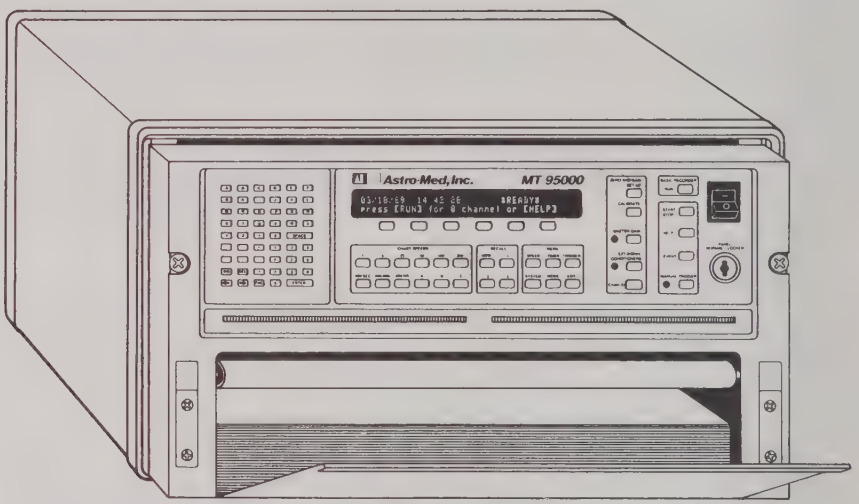
5. Insert the top sheet (arrows pointing to the rear of the recorder) into the slot beneath the drive roller. The drive roller is located directly under the front panel light bars.

6. Manually feed the paper into the recorder and around the drive roller by carefully sliding the paper forward.

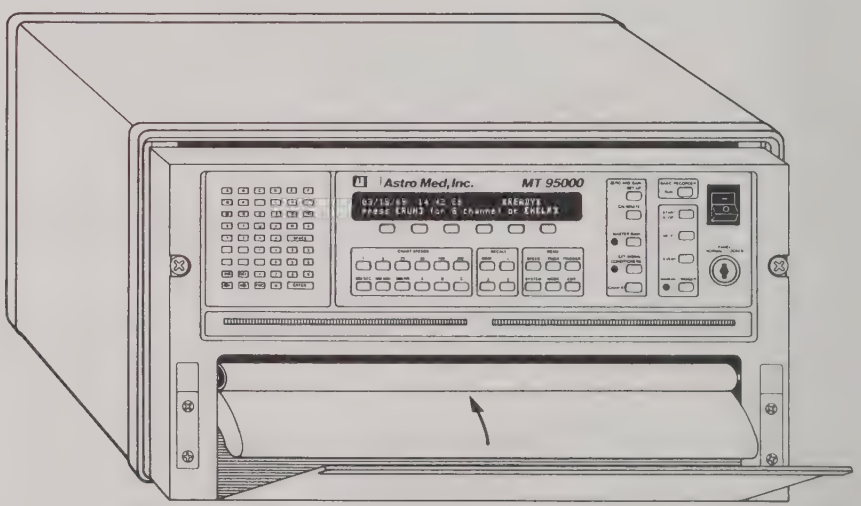
7. Push the paper forward until it passes around the drive roller and begins to exit the recorder at the slot above the drive roller.

8. When the paper begins to exit the recorder, evenly pull out a length of approximately six inches or more.

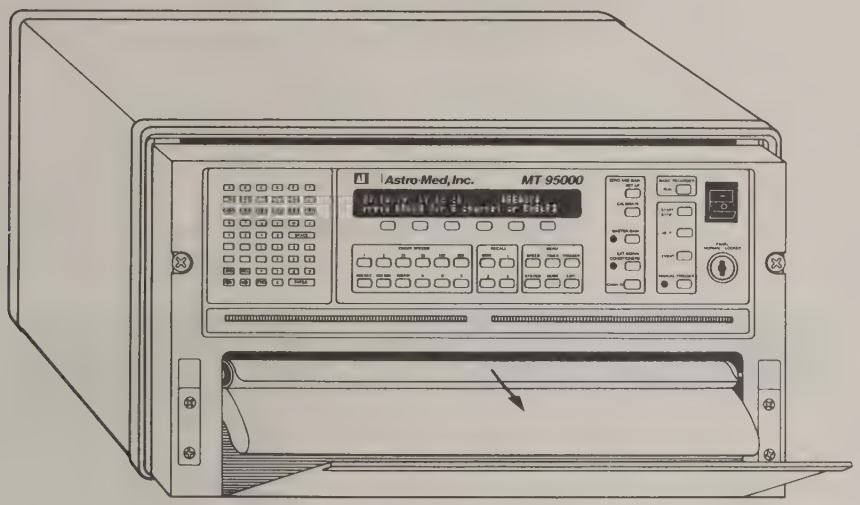
position Z-fold paper for insertion



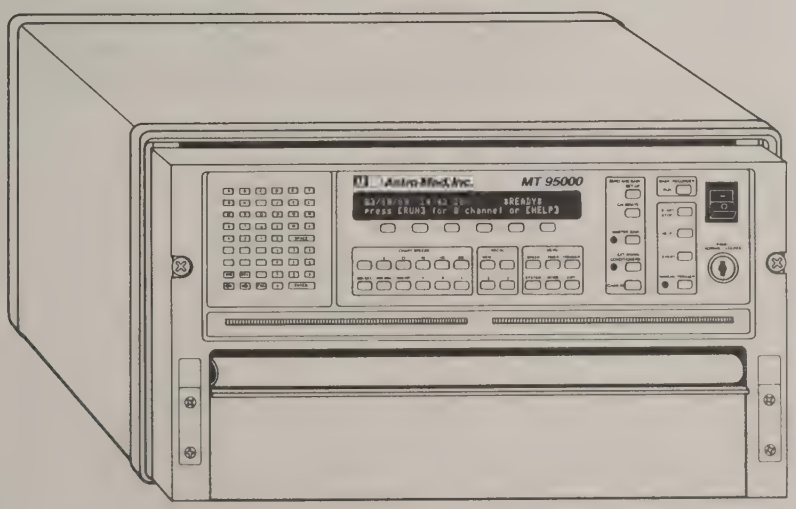
insert Z-fold paper beneath drive roller



Z-fold paper exits above drive roller



close paper chamber door



9 Ensure that the chart-paper pack is fully inserted into the paper chamber by pushing it to the rear of the chamber.

10 Hold the six-inch paper lead out of your way and close the paper-chamber door.

You will hear a slight click when the door closes and feel it snap secure. The recorder is now loaded with a pack of thermal Z-fold chart paper.

11 If you have loaded the paper with the recorder turned off, turn the recorder on by flicking the POWER rocker switch to the "on" position.

To monitor paper consumption

The sheets of the paper pack are numbered in descending order from 500 to 1. The page numbers appear along the center line of the chart paper. This keeps you exactly informed about the number of chart-paper sheets remaining in the recorder.

If any of the following conditions exist:

- no paper is in the recorder
- the paper pack has been incorrectly inserted
- the chart paper runs out during recording
- the paper-chamber door is open

the recorder will display the following message:

To correct this and return the recorder to operational condition, either:

- Insert chart paper into the empty recorder following steps 1 through 10 above,
- Remove the incorrectly installed chart paper and properly reinsert it following steps 1 through 10 above, or
- Ensure that the paper-chamber door is closed.

Loading Roll Thermal Paper

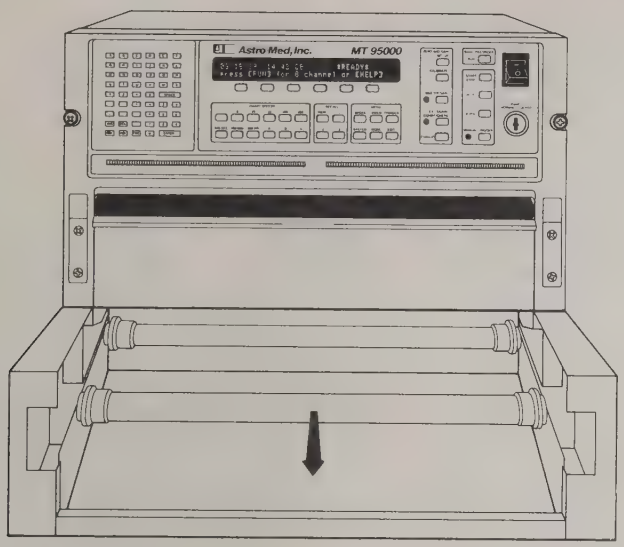
Please note that some thermal papers can leave a residue which will eventually clog and damage the recorder's printheads. Other papers have a coarse surface texture that can cause excessive printhead wear. Astro-Med chart paper is manufactured by Astro-Med to exacting standards that eliminate this potential problem. For best results, you must use Astro-Med thermal roll chart paper exclusively.

The accompanying figures illustrate:

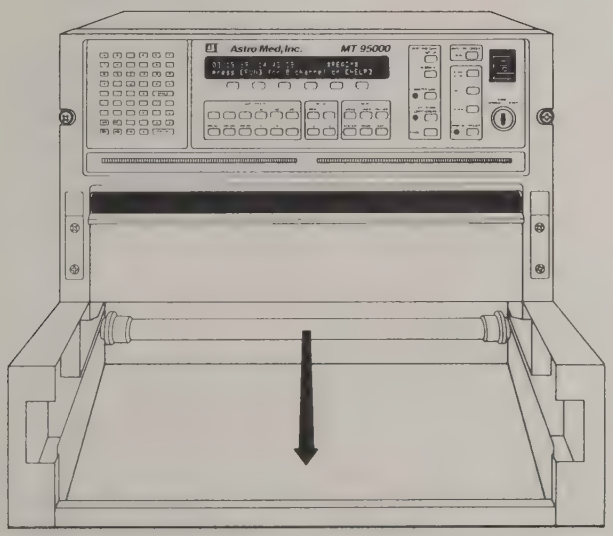
- loading the rewinder with a roll of thermal paper
- threading the roll thermal paper through the recorder
- securing the paper to the rewinder's take-up spool for automatic collection

Roll thermal paper can only be used by the recorder when the recorder is equipped with the rewinder. The roll paper supply is located in the rewinder. The instructions provided below assume that your chart recorder and rewinder have been correctly attached to one another. If your recorder is being used with the writing table, the writing table must be removed before the chart paper can be loaded. In the steps given below, "left" refers to the left of the rewinder as you view it from the front. "Right" refers to the right of the rewinder as viewed from the front.

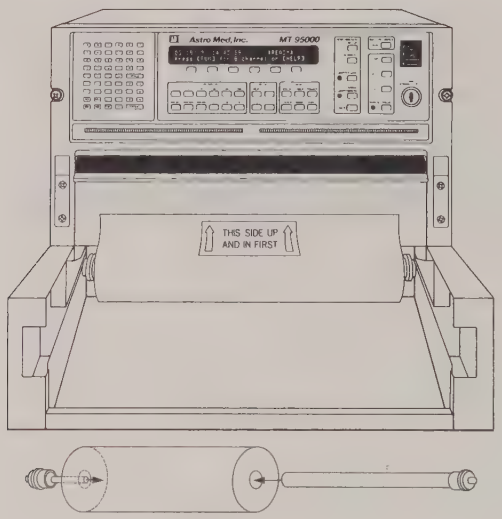
remove paper take-up reel



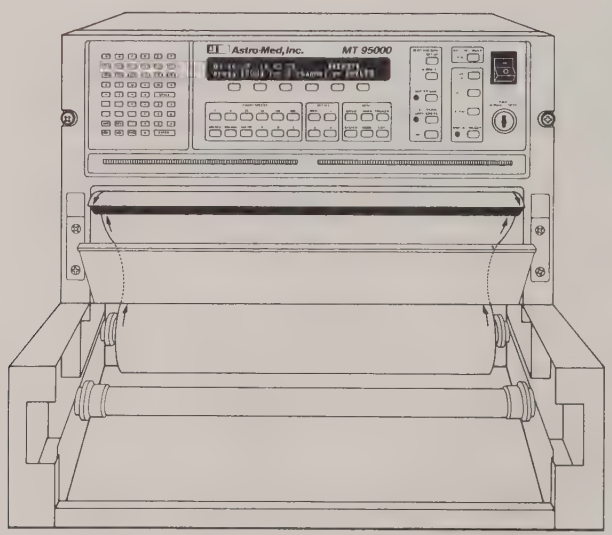
remove paper supply reel



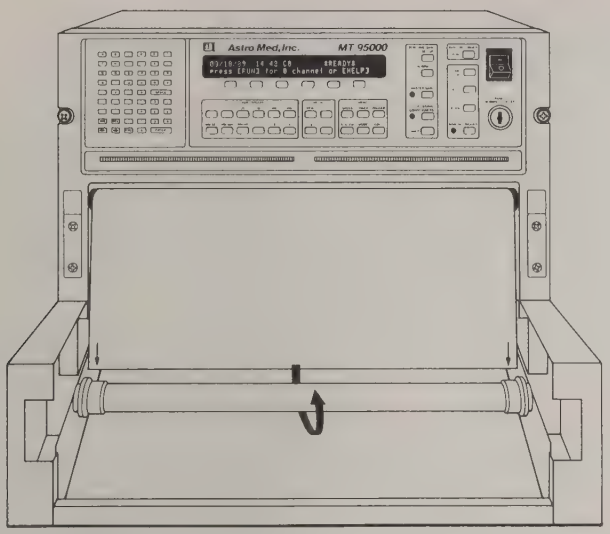
insert loaded paper supply reel



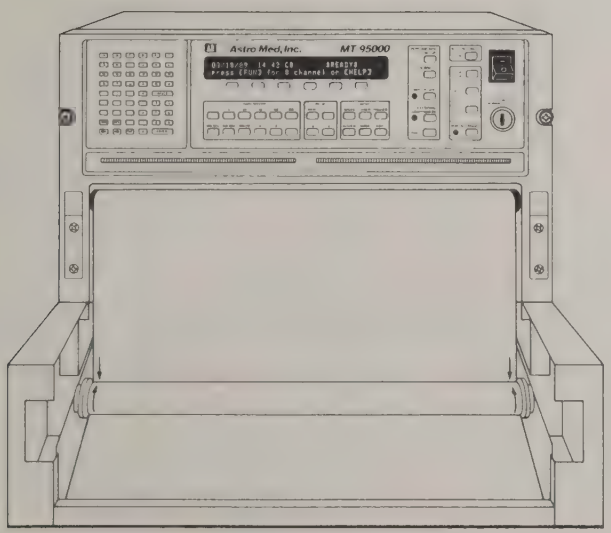
feed roll paper through recorder



advance paper to paper take-up reel



attach paper to paper take-up reel



1 Remove the writing table if present.

2 As described below, remove the rewinder's chart paper take-up reel by individually lifting the exterior latches that visibly protrude from the slots in the rewinder's left and right front corner covers. These latches secure the chart paper take-up reel to the rewinder. The take-up reel is the rewinder's front-most reel.

- Continuously lift the left exterior latch, grasp the left hub of the core of the take-up reel, and pull the core toward you. This will free the left hub of the take-up reel.
- Continuously lift the right exterior latch, grasp the right hub of the core of the take-up reel, and pull the core toward you. This will free the right hub of the take-up reel.
- Grasp the freed take-up reel and remove it from the rewinder.

3 Remove any chart paper accumulated on the take-up reel.

This is done by grasping, pulling, and removing the circular left hub of the take-up reel. The left hub of the reel does not have a gear on it. The right hub of the reel has a gear on it. The spooled paper will have been rewound onto a cardboard tube core. Slide the rewound paper/core off the take-up reel.

4 Place an empty cardboard core on the take-up reel and reinstall the circular left hub of the take-up reel. Set the take-up reel aside.

5 Unlatch the supply reel for removal from the rewinder.

Reach inside the front of the rewinder and find the latches that secure the chart-paper supply reel. The supply reel is the rewinder's inner-most reel. The latches that secure the supply reel are located near the upper left and upper right sides of the rewinder's interior. You can feel these inner latches extending toward the front of the rewinder. The latches are spring loaded and their tips are bent to form a flat surface for pushing. Individually push each latch back and down. The latches will snap into place and free the supply reel for removal.

6 Reach into the interior of the rewinder and remove the supply reel.

7 The supply reel has one removable hub. Try each hub of the supply reel and remove the detachable hub.

Remove and save the empty core. You will be able to use the empty core on the rewinder's take-up reel. When you reinsert the supply reel (steps 8 - 10), the removable hub can be positioned on either the left or right side of the rewinder. However, the roll thermal paper must be oriented as described in steps 8 and 9 below.

8 Place a roll of thermal paper on the supply reel and reinsert the removed hub of the reel.

The roll thermal paper carries a stamp reading "THIS SIDE UP AND IN FIRST." Two directional arrows are also on the stamp. Make sure that the "THIS SIDE UP AND IN FIRST" stamp is right-side up and readable. The two directional arrows must point to the interior of the rewinder. Each sheet of Z-fold chart paper is marked with a black rectangle referred to as the index mark or top-of-form mark.This is used by the recorder to position the paper to a point just below the Z-fold perforation. Roll thermal paper has an index mark every 280 mm.

9 Place the supply reel with its new roll of thermal paper horizontally into the rewinder resting across the interior rails.

Make sure that the "THIS SIDE UP AND IN FIRST" stamp is right-side up and readable. The two directional arrows must point to the interior of the rewinder.

10 Slide the loaded supply reel into the interior of the rewinder along the rails on which it rests until the reel drops into place.

You will feel the hubs of the reel drop into place when the reel has been inserted as far as it will go.

11 When the supply reel has dropped into place, individually press and slightly push up the left and right interior latches that secure the reel.

When pressed and slightly pushed upwards, the latches will snap forward into place and hold the reel in proper position.

12 Take the end of the thermal roll and unwind six to twelve inches of paper. Slide the paper through the space availableat the bottom of the paper-chamber door.

The paper chamber door is hinged at the bottom. When the door is partially opened, space is created and the paper can be fed through easily.

13 With the paper chamber door open, slide the end of the paper into the slot beneath the recorder's drive roller.

14 Push the paper forward until it passes around the drive roller and begins to exit the recorder at the slot above the drive roller. Close the paper-chamber door.

15 Reinsert the paper take-up reel with its empty core (step 5) by placing it horizontally in front of the left and right take-up reel latches (step 1) near the front of the rewinder. The gear on the take-up reel must be to the right as you face the rewinder. Push the take-up reel against the latches. The latches will rise and the take-up reel will fall into position as the latches snap down to secure it.

16 Pull the paper through the slot above the drive roller and down to the rewinder's take-up reel. Pass the paper behind and under the core of the take-up reel. Bring the paper up to the front of the take-up reel. Fold the paper back several inches and manually tuck the creased paper around the take-up reel to secure the paper on the core. As necessary, use your hand to turn the take-up reel to wind several inches of paper securely onto the core.

17 Press the circular power button on the front left panel of the rewinder to turn the accessory on.

18 Turn the recorder on.

Rewinder ready to spool paper

You are now ready to use the rewinder to spool chart paper as it exits the recorder. The rewinder has a constant-torque motor that applies proper tension to the chart paper. The rewinder works with all recorder chart-paper speeds.

The paper roll is marked into lengths numbered in descending order from 500 to 1. The numbers appear along the center line of the chart paper. This helps to keep you informed regarding the amount of chart paper remaining in the recorder.

If any of the following conditions exist:

- no paper is in the recorder
- the paper roll has been incorrectly inserted
- the chart paper runs out during recording
- the paper-chamber door is open

the recorder will display the following message:

To correct this and return the recorder to operational condition, either:

- Insert chart paper into the empty rewinder and recorder following steps 1 through 16 above,
- Remove the incorrectly installed chart paper and properly reinsert it following steps 1 through 16 above, or
- Ensure that the paper-chamber door is closed.

3-5 Use of Front Panel Controls

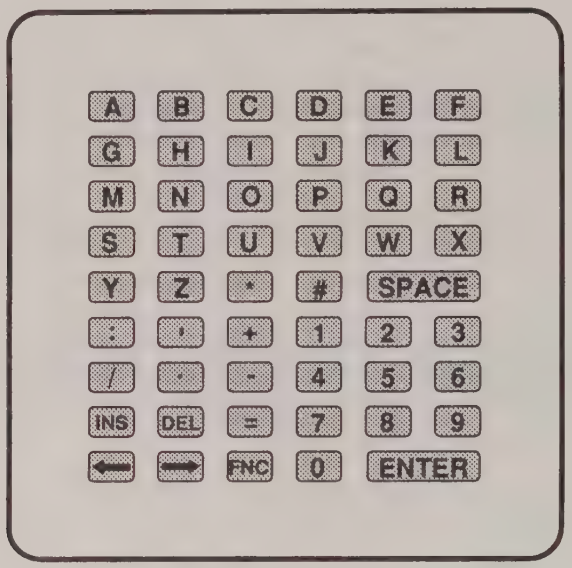
Use of the front panel controls is discussed in the following order: alphanumeric keypad, CHART SPEEDS group, RECALL group, MENU group, SIGNAL CONDITIONER group, BASIC RECORDER RUN, and OPERATIONS group.

As you use the controls of the front panel, remember that, when a setting is shown on the front panel display, that setting takes immediate effect. You do not have to press an "ENTER" key to confirm your action. This saves you keystrokes.

The one exception to this occurs when defining the SPEED key of the MENU group. When entering a chart speed in this method, you must confirm your choice by pressing the ENTER key of the alphanumeric keypad.

Use of the front panel keys results in many different menus that are shown on the front panel display. Consult appendix A for a complete overview of all menus. Appendix A consists of three fold-outs: Menus of the Front Panel Keys at a Glance, Menus of the Mode Key at a Glance, and Menus of the System Key at a Glance.

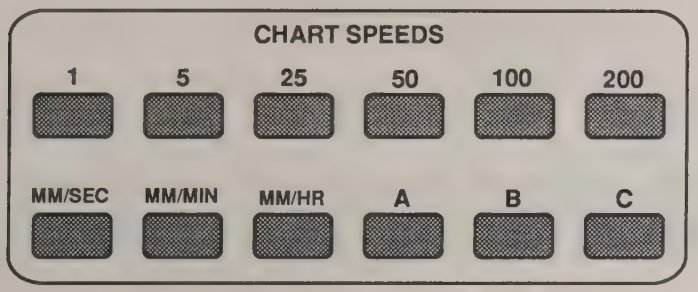
Alphanumeric Keypad



The alphanumeric keypad is used to enter and delete information in the recorder's interchannel buffers. When the recorder's [EDIT] key has been invoked, the alphanumeric keypad can be used to enter and delete information from the interchannel buffers. The discussion of the [EDIT] key provides full explanation of editing the contents of interchannel buffers.

The keypad is also occasionally used to change certain recording parameters.

CHART SPEEDS Group



The keys of the top row of the CHART SPEEDS group are labeled 1, 5, 25, 50, 100, and 200 indicating six instantly selectable speeds.

The MM/SEC, MM/MIN, and MM/HR keys of the bottom row are used to select the speed range: millimeters per second, minute, or hour.

The A, B, and C keys of the bottom row are individually programmable "insta speed" keys. Use them to program speeds that may be frequently used but are not available through the fixed speeds of the CHART SPEEDS group.

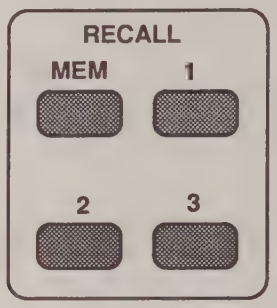
To program the A, B, and C keys, refer to the discussion of the INSTA SPDS setup within the overall explanation of the SYSTEM key.

When you are recording in any real-time mode and you press any speed or insta speed key from the CHART SPEEDS group, that speed is immediately implemented. The previous speed is lost.

The recording speed remains as selected until:

- another key of the CHART SPEEDS group is pressed; or
- the real-time recording mode menu that has been changed is accessed and its speed (SPD) parameter is redefined.

RECALL Group



MEM invokes menu to save system setups

1, 2, and 3 either save or replace current system setups

The keys of the RECALL group allow you to store and recall three complete system setups. Consequently, the RECALL Group is a particularly useful feature if your requirements demand the frequent use of a number of differently configured system setups.

Recall Group:
To program a complete system setup into a RECALL key

1 Press the SYSTEM key of the MENU group.

2 Use the SYSTEM key menu and to set each recording parameter.

As you change each recording parameter, remember that any ongoing recording is immediately changed to reflect the newly defined setting.

3

Press the MEM key of the RECALL group.

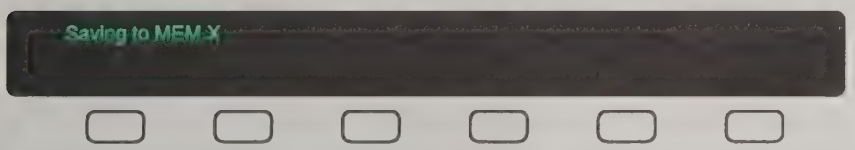
When the MEM key is pressed, the following menu option results:

This indicates that all of the setup parameters defining the current system will be saved into the RECALL Group's individual 1, 2, or 3 key when the key is pressed.

4

Press the RECALL group numeric key into which you want to store the system you just defined.

When the desired storage key is pressed, the front panel display reads:

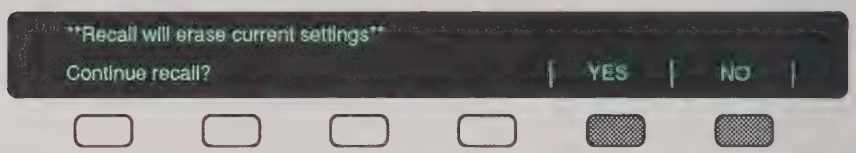


where X is the selected key number

Recall Group:
To retrieve a system setup using a RECALL key

1 Press the RECALL group numeric key containing the system setup that you want to invoke: either 1, 2, or 3.

This results in the following display.



This message indicates that all ongoing recording parameters will be replaced with those of the recalled setup when the RECALL setup key is pressed.

2 Press the soft key under the front panel display that corresponds to either the YES or NO choice.

Pressing NO returns the recorder to its base display.

Pressing YES results in the following display:

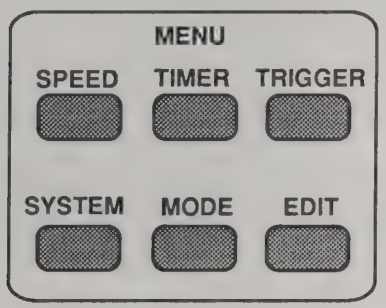
where X is the selected key number

Recall Group:
To get a list of system parameters stored in RECALL keys

1 Press the recorder's HELP key.

2 Press the STAT selection from the resulting menu.

MENU Group



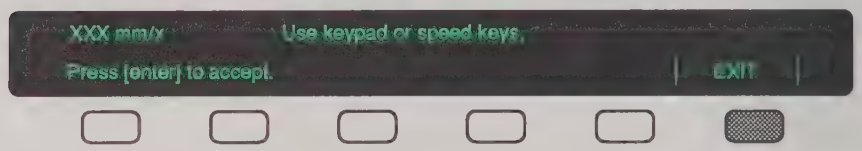
MENU group invokes recorder's primary operational menus

The MENU group consists of six keys labeled SPEED, TIMER, TRIGGER, SYSTEM, MODE, EDIT. The use of each key is explained below.

SPEED Key

The SPEED key provides direct access to the speed menu. This allows you to specify any valid chart speed that might not be immediately available through the keys of the CHART SPEEDS group.

Pressing the SPEED key results in the following front-panel display:



where: XXX is the speed that you specify.
mm/x is millimeters per second, minute, or hour per your choice.

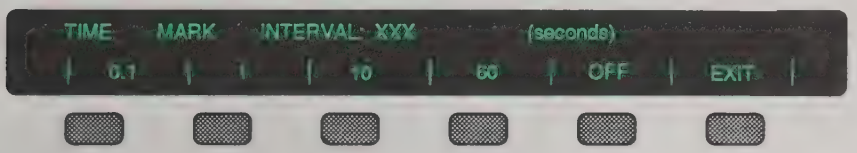
Use the alphanumeric keypad to enter the speed you want to implement. (You can also use any of CHART SPEEDS keys to directly enter a preset speed.)

Press the [ENTER] key to have the chart recorder accept the speed. When you press [ENTER], the recorder accepts the speed and returns to the front-panel base display.

Pressing EXIT before the speed has been entered aborts the chart speed change and returns the recorder to the base front panel display.

TIMER Key

Pressing the TIMER key causes the timing mark menu to be shown on the front-panel display.

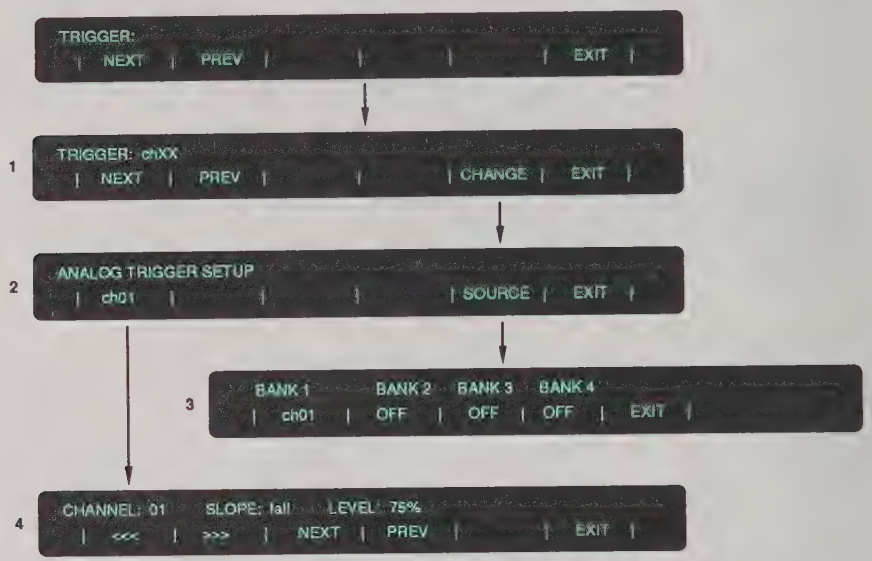


Choosing any of the timing mark options causes the recorder to print timing marks along the left edge of the chart paper at the time interval selected. Timing marks appear as small "tick marks."

Press the soft key beneath the desired timing mark interval to initiate printing of the mark. Timing marks can be printed at intervals of 1/10th second, 1 second, 10 seconds, and 60 seconds. Pressing OFF causes the recorder to stop printing timing marks. Pressing EXIT returns the recorder to the front-panel base display.

TRIGGER Key

Pressing the TRIGGER key invokes the TRIGGER prime menu and four submenus.



The trigger menus are used to define:

- the trigger source:

  (1) manual, (2) external, (3) host computer,
  (4) analog channel, (5) manual or external in combination,
  (6) manual or host computer in combination,
  (7) manual or analog channel in combination

- the analog channels that will function as trigger channels and the A/D boards on which the trigger channels reside.

- the slope on which the recorder will recognize a trigger: rising, falling, or both.

- the level of the full scale voltage range at which a trigger will be detected.

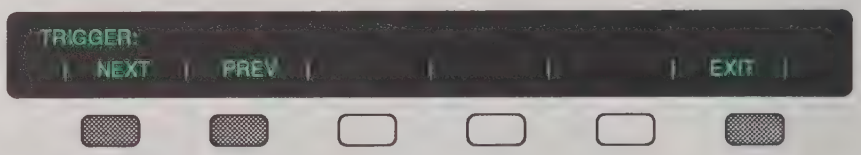
- trigger off.

Each 4-channel A/D board can have only one active trigger channel. This means that:

- for an 8-channel system,
  two trigger channels can be active.

- for a 12-channel system,
  three trigger channels can be active.

- for a 16-channel system,
  four trigger channels can be active.



NEXT or PREV

Pressing the soft keys beneath NEXT and PREV in the TRIGGER key prime menu scrolls forward or backward through the available trigger source options. Note that as either key is pressed, the options appear in the display next to the word "TRIGGER".

The trigger source options available from the prime menu are:

off disables all triggers.

manual causes the recorder to respond only to triggers initiated from the MANUAL TRIGGER key.

external causes the recorder to respond only to triggers initiated through an externally generated TTL pulse or switch closure.

host causes the recorder to respond only to triggers initiated by a host computer.

analog channel causes the recorder to respond to triggers sensed in the selected analog channel. The abbreviation "chXX" is shown in the display. XX are the numbers of a specific channel. The analog trigger option and the manual-or-analog-channel option both cause the word CHANGE to appear in the front panel display. This is used to invoke three submenus explained below.

manual or external causes the recorder to respond to triggers initiated through either the MANUAL TRIGGER key or through an externally generated TTL pulse or switch closure.

manual or host causes the recorder to respond to triggers initiated through either the MANUAL TRIGGER key or through a host computer.

manual or analog channel causes the recorder to respond to triggers initiated through the MANUAL TRIGGER key or to triggers sensed in the selected analog trigger.

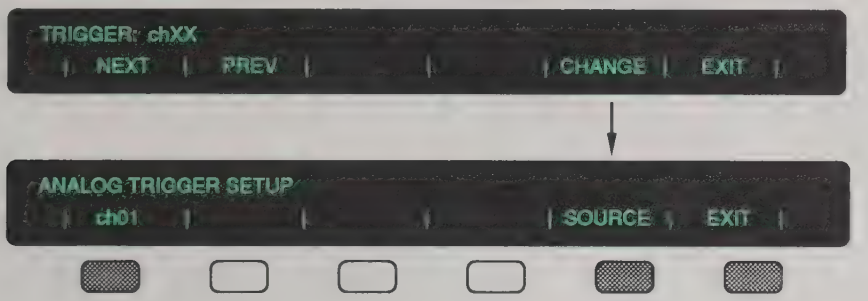
When you select either an analog channel or the "manual or analog channel" option as the trigger source, the word CHANGE appears in the displayed menu. This new menu is trigger submenu 1 and is discussed below.

EXIT Pressing the soft key beneath the prime menu EXIT returns the recorder to its base display.

NEXT or PREV — Pressing the soft keys beneath the NEXT or PREV choices scrolls through the trigger source options already discussed.

CHANGE — Pressing the soft key beneath the CHANGE option invokes trigger submenu 2 discussed below.

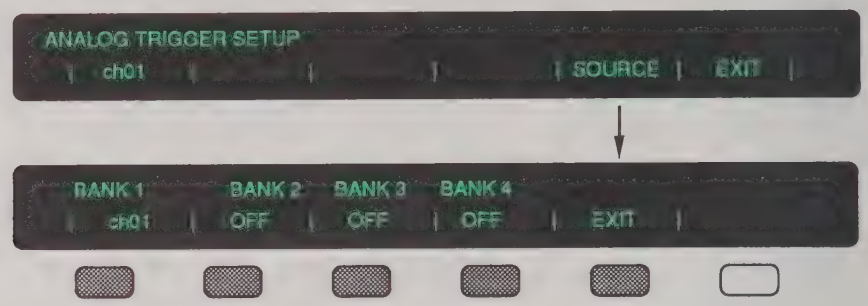
EXIT — Pressing the soft key beneath the EXIT option returns the recorder to its base display.



chXX Pressing the soft key beneath the chXX option invokes submenu 4 discussed immediately after submenu 3.

SOURCE Pressing the soft key beneath the SOURCE option invokes submenu 3 shown below.

EXIT Pressing the soft key beneath the EXIT option returns the recorder to its base display.



Submenu 3 allows you to:

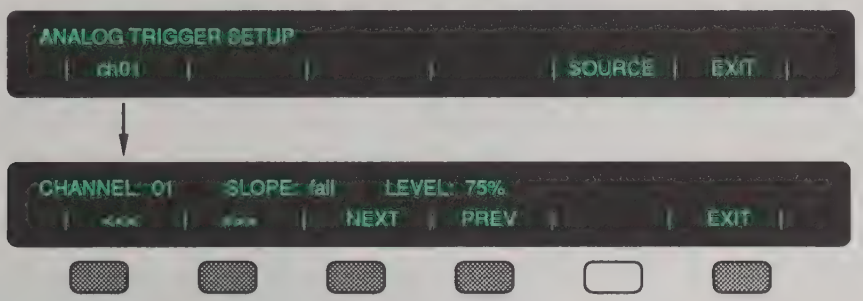
- choose one trigger channel from each installed A/D board (BANK)
- disable (turn OFF) the designated trigger channel on each A/D board.

BANK Pressing the soft key beneath any of the BANK options scrolls through the channel selections available for that A/D board.

BANK 1 options: OFF, ch01, ch02, ch03, ch04
BANK 2 options: OFF, ch05, ch06, ch07, ch08
BANK 3 options: OFF, ch09, ch10, ch11, ch12
BANK 4 options: OFF, ch13, ch14, ch15, ch16

Even if your recorder is not configured with a full four A/D BANKs, the front panel display will list BANKS 1 through 4. BANKs for which no A/D board is installed will not be functional.

EXIT Pressing the soft key beneath EXIT returns the recorder to the TRIGGER prime menu.



For the selected trigger channel, submenu 4 allows you to define the SLOPE on which the trigger will be detected and the percentage of the full scale voltage LEVEL that will constitute a trigger.

<<< or >>> Pressing the soft keys beneath either <<< or >>> alternately selects either the displayed SLOPE or LEVEL parameter for change.

NEXT or PREV Pressing the soft keys beneath the NEXT or PREV options scrolls through the choices available within the selected SLOPE or LEVEL parameter.

If SLOPE is selected as the parameter being defined, the NEXT or PREV options scroll through the following choices: rise, fall, or both.

If LEVEL is selected as the parameter being defined, the NEXT or PREV options scroll through trigger levels of 1% through 100% in 1% increments.

EXIT Pressing the soft key beneath EXIT returns the recorder to its base display.

Pressing the SYSTEM key invokes the first of four successive displays that comprise the SYSTEM key prime menu. For clarity, each display will be considered a level of the prime menu and will be discussed as Level 1, Level 2, etc. The SYSTEM key prime menu provides access to the menus that define the chart recorder's fifteen principal setup categories.

Each selection of the SYSTEM key prime menu has its own set of submenus. Each submenu is used to define one or more setup parameters. Each setup parameter has its own effect the appearance and content of the printed chart. Together, the parameters defined under the SYSTEM key make up a total system setup.

Table 3-1 provides a comprehensive list of the setup parameters accessed under the SYSTEM key.

Table 3-1.
System Setups Defined Using the SYSTEM Key

1 .....interchannel annotation
2 .....channel order
3 .....grid on/off
4 .....grid minor divisions on/off
5 .....pen lift/down
6 .....sample rate
7 .....trace percentage
8 .....memory division
9 .....number of ksamples
10 .....acquisition auto/manual rearm
11 .....playback format
12 .....playback magnification/reduction
13 .....playback percentage
14 .....playback manual/automatic
15 .....trigger source
16 .....trigger channel bank
17 .....trigger channel
18 .....trigger slope
19 .....trigger level
20 .....GPIB communications
21 .....GPIB address
22 .....GPIB terminator
23 .....default parameters
24 .....motor clock source internal/external
25 .....insta speed definition
26 .....time source:
internal/IRIG A/ IRIG B / IRIG H / NASA 36
28 .....signal conditioner reporting enable/disable
29 .....numerical output

When the SYSTEM key is pressed, Level 1 of the prime menu is displayed.

Level 1 of the SYSTEM prime menu allows you access menus that define the recording setups listed below.

INTER CHAN Pressing the soft key beneath INTER CHAN invokes menus used to print or suppress interchannel annotation or event markers (if the event-marker option is installed).

CHAN ORDER Pressing the soft key beneath CHAN ORDER invokes menus used to define the order in which channels are printed from right to left across the chart as viewed from the front of the recorder.

GRID SET Pressing the soft key beneath GRID SET invokes menus used to either enable or suppress grid printing. Enables or suppresses printing of minor divisions across the grid.

INVERT/LIFT Pressing the soft key beneath INVERT/LIFT invokes menus (1) used to print the signal with either normal or inversed polarity and (2) used to determine whether an individual channel will be printed ("pen down") or not printed ("pen up").

more Pressing the soft key beneath "more" invokes Level 2 of the SYSTEM prime menu.

SYSTEM Key Prime Menu: Level 1—
INTER CHAN setup

Pressing the soft key beneath the INTER CHAN display invokes the menu that selects or suppresses the printing of alphanumeric annotation in the recorder's interchannel buffers.

INC Pressing the soft key beneath INC selects the next higher channel.

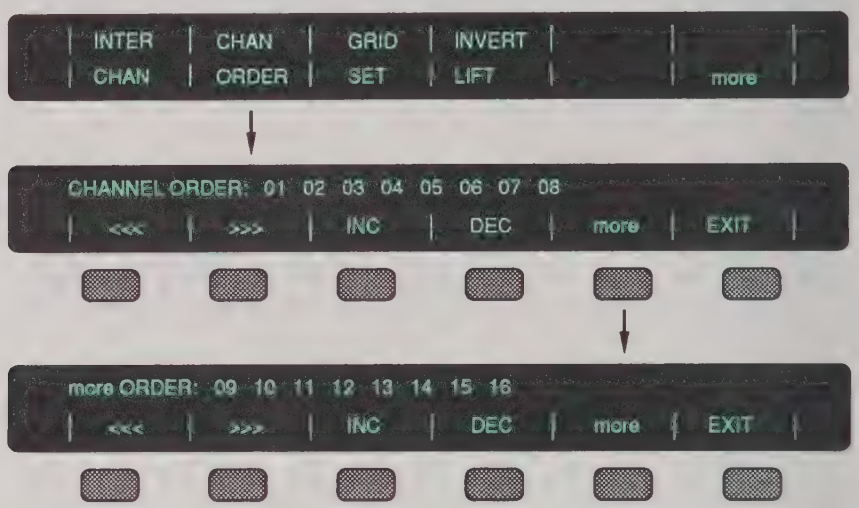
DEC Pressing the soft key beneath DEC selects the next lower channel.

NONE Pressing the soft key beneath NONE suppresses printing of interchannel annotation.

ANNOT Pressing the soft key beneath ANNOT selects printing of interchannel annotation.

EVENT Pressing the soft key beneath EVENT selects interchannel event markers for display in the indicated interchannel buffer.

EXIT Pressing the soft key beneath EXIT returns the recorder to the Level 1 display of the SYSTEM prime menu.



Pressing the soft key beneath the CHAN ORDER display invokes the menu that defines the order in which channels are printed from left to right across the chart paper.

<<< Pressing the soft key beneath the <<< symbol moves through the channels shown in the display from right to left. When a channel is selected, it blinks regularly indicating it can be changed.

>>> Pressing the soft key beneath the >>> symbol moves through the channels shown in the display from left to right. When a channel is selected, it blinks regularly indicating it can be changed.

INC Pressing the soft key beneath INC moves the selected channel to the next higher channel number.

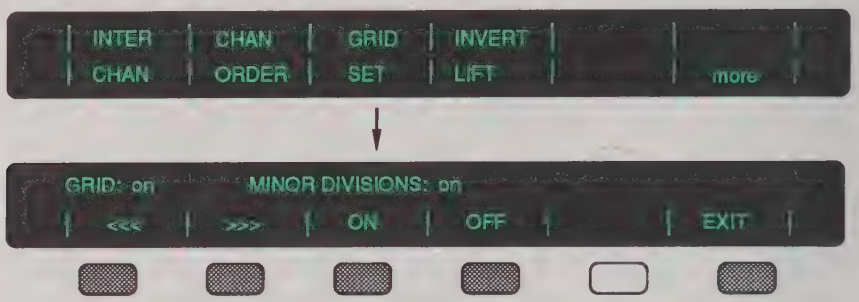
DEC Pressing the soft key beneath DEC moves the selected channel to the next lower channel number.

more If your chart recorder is a 12- or 16-channel system, pressing the soft key beneath "more" invokes the menu for changing the order the additional banks of channels.

EXIT Pressing the soft key beneath EXIT returns the recorder to the Level 1 display of the SYSTEM prime menu.

SYSTEM Key Prime Menu: Level 1—

GRID SET setup



Pressing the soft key beneath GRID SET invokes the menu that enables or suppresses grid printing on the recorded chart. If grid printing is on, the GRID SET menu is used to enable or suppress the printing of minor grid divisions on the chart

<<< Pressing the soft key beneath the <<< symbol selects from right to left either the MINOR DIVISIONS parameter or the GRID parameter. When a parameter is selected, it blinks regularly indicating it can be changed.

>>> Pressing the soft key beneath the >>> symbol selects from left to right either the GRID parameter or the MINOR DIVISIONS parameter. When a parameter is selected, it blinks regularly indicating it can be changed.

ON Depending on the currently selected parameter, pressing the soft key beneath ON either:

- enables the printing of a grid.
- enables the printing of minor divisions in the selected grid.

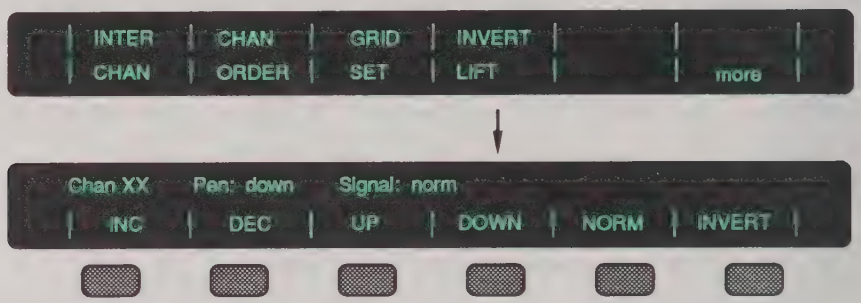
OFF Depending on the currently selected parameter, pressing the soft key beneath OFF either:

- suppresses the printing of a grid.
- suppresses the printing of minor divisions in the selected grid.

EXIT Pressing the soft key beneath EXIT returns the display to Level 1 of the SYSTEM key prime menu.

SYSTEM Key Prime Menu: Level 1—

INVERT LIFT setup



Pressing the soft key beneath INVERT LIFT invokes the menu that enables or disables the printing of individual channels. The menu also determines whether a signal is printed with normal polarity or reversed polarity.

INC Pressing the soft key beneath INC moves the selected channel to the next higher channel number.

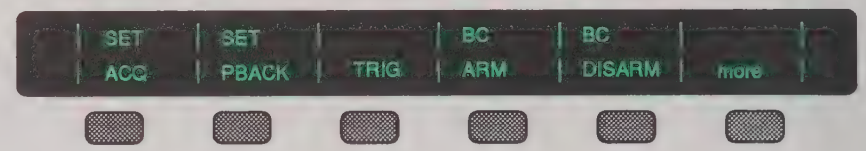
DEC Pressing the soft key beneath DEC moves the selected channel to the next lower channel number.

UP Pressing the soft key beneath UP causes the Pen selection parameter to read "up." This results in suppression of printing in the selected channel. This is analogous to the old technology "pen up" condition. The UP selection applies only to the Pen parameter.

DOWN Pressing the soft key beneath DOWN causes the Pen selection parameter to read "down". This empowers printing in the selected channel. This is analogous to the old technology "pen up" condition. The UP selection applies only to the Pen parameter.

NORM Pressing the soft key beneath NORM causes Signal parameter to read "norm." This indicates that the waveform will be recorded with normal signal polarity. The NORM selection applies only to the Signal parameter.

INVERT Pressing the soft key beneath INVERT causes the Signal parameter to read "inverted." This indicates that the waveform will be recorded with inverted signal polarity. The INVERT selection applies only to the Signal parameter.



When the soft key beneath "more" in Level 1 of the SYSTEM prime menu is pressed, level 2 of the prime menu is displayed.

Level 2 of the SYSTEM prime menu allows you access to menus that define the recording setups defined below.

SET ACQ Pressing the soft key beneath SET ACQ invokes menus that define data capture acquisition parameters.

SET PBACK Pressing the soft key beneath SET BPACK invokes menus that define parameters relevant to the playback of captured data.

TRIG Pressing the soft key beneath TRIG invokes menus that define parameters relevant to data capture triggers. The TRIG menus accessed through theSYSTEM key are the same menus accessed through the TRIGGER key of the MENU group. Please refer to the discussion of the TRIGGER key for information regarding the TRIGGER menus.

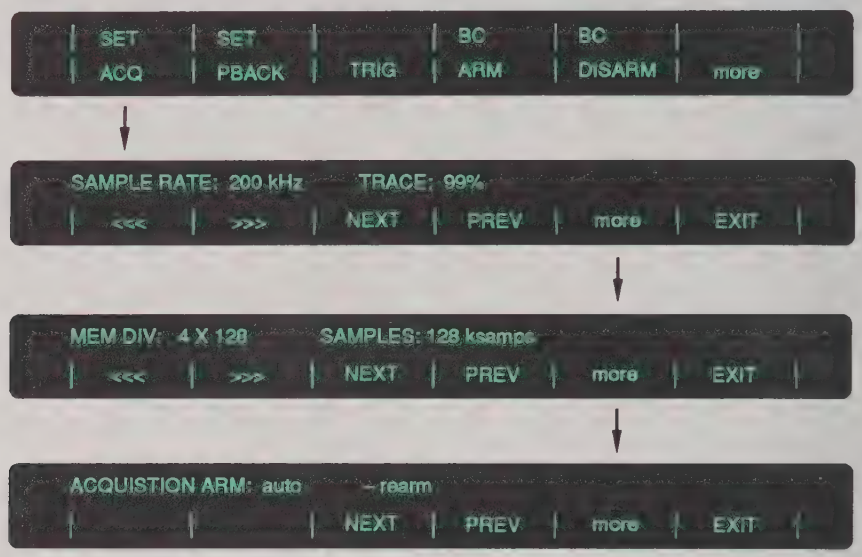
BC ARM Pressing the soft key beneath BC ARM arms background data capture.

BC DISARM Pressing the soft key beneath BC ARM disarms background data capture.

more Pressing the soft key beneath "more" invokes the Level 3 of the SYSTEM key prime menu.

SYSTEM Key Prime Menu: Level 2—

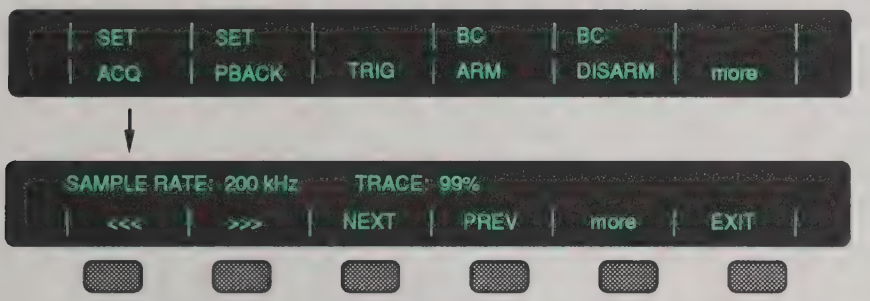
SET ACQ submenu sequence



Pressing the soft key beneath SET ACQ invokes the menu sequence that defines data acquisition parameters.

SYSTEM Key Prime Menu: Level 2—

SET ACQ submenu 1



SET ACQ submenu 1 is used to specify the rate at which the MT-95000/MT-96000 will sample data.

<<< Pressing the soft key beneath <<< moves from right to left selecting either the TRACE parameter or the SAMPLE RATE parameter for definition.

>>> Pressing the soft key beneath >>> moves from left to right selecting either the SAMPLE RATE parameter or the TRACE parameter for definition.

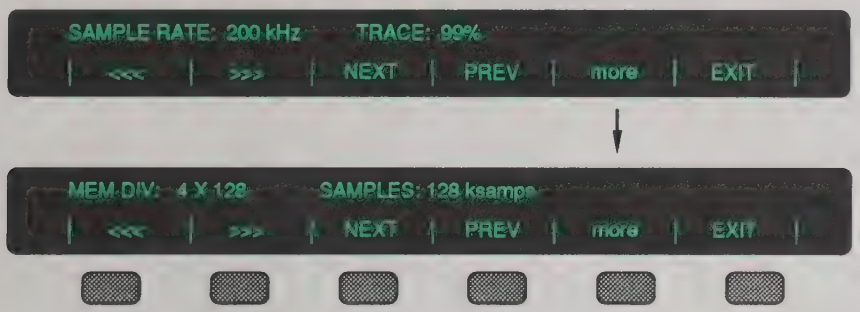
NEXT or PREV Pressing the soft key beneath either NEXT or PREV:

- when SAMPLE RATE is selected , scrolls either forward or backward through nine available sample rates: 1, 5, 10, 20, 25, 40, 50, 100, 200.
- when TRACE is selected, scrolls either forward or backward through the available data capture pre- and post-trigger percentages: start, center, end, and 1% through 100% in 1% increments. The alphanumeric keypad is used to specify the desired numeric percentage.

more Pressing the soft key beneath "more" selects SET ACQ submenu 2.

EXIT Pressing the soft key beneath EXIT returns the display to Level 1 of the SYSTEM key prime menu.

SYSTEM Key Prime Menu: Level 2—
SET ACQ submenu 2



Submenu 2 is used to allocate the recorder's data-capture sample memory resources and specify the number of kilosamples to be stored in each channel's sample memory. You cannot specify the memory allocations of each individual A/D board in your system. Instead, the memory allocations you select through this menu apply collectively to all the A/D boards in your recorder.

<<< or >>> Pressing the soft key beneath either <<< or >>> selects either the MEM DIV parameter or the SAMPLES parameter for definition. [<<<] selects each parameter from the left. [>>>] selects each parameter from the right.

NEXT or PREV

Pressing the soft key beneath either NEXT or PREV:

- when MEM DIV is selected, alternates the display between two alternatives for data-capture memory allocation: (1) each of the four channels of each A/D board captures a maximum of 128k samples or (2) the first of the four channels of each A/D board captures a maximum of 512k samples.
- when SAMPLES is selected, scrolls either forward or backward through available data capture sample settings: 4, 8, 12, ... 128 in 4k increments.

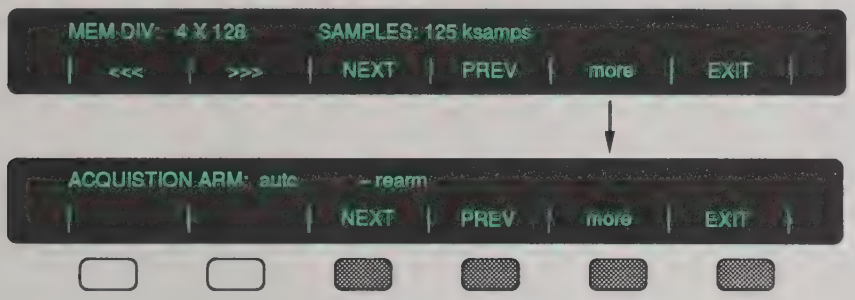
more

Pressing the soft key beneath "more" selects SET ACQ submenu 3.

EXIT

Pressing the soft key beneath EXIT returns the display to Level 1 of the SYSTEM key prime menu.

SYSTEM Key Prime Menu: Level 2—
SET ACQ submenu 3



Submenu 3 is used to specify either manual or automatic data capture readiness. When a trigger has been defined and the chart recorder is operating in the Data Capture mode,

- if the ACQUISITION ARM parameter is set for "auto," data will be automatically acquired when a trigger is sensed.
- if the ACQUISITION ARM parameter is set for "manual," data will be acquired only when:

  - the Data Capture (manual arm - manual playback option) menu structure is entered and

  - the soft key beneath RUN is pressed.

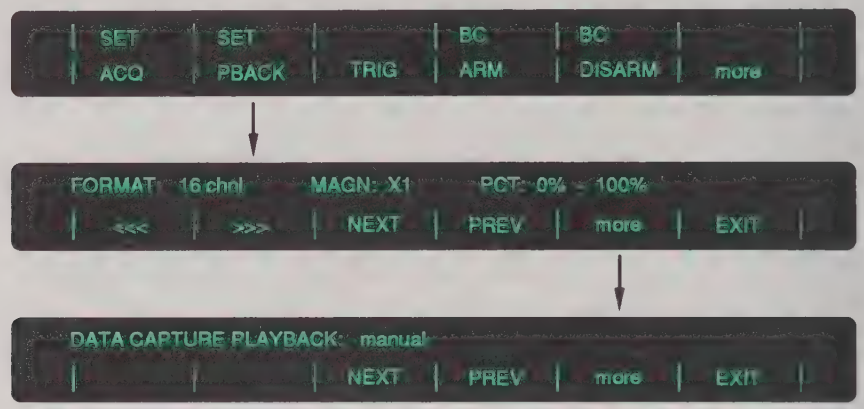
NEXT or PREV Pressing the soft key beneath either NEXT or PREV causes the displayed ACQUISITION ARM parameter to alternate between "manual" and "auto" rearm.

more Pressing the soft key beneath "more" returns the display to SET ACQ submenu 2.

EXIT Pressing the soft key beneath EXIT returns the display to Level 1 of the SYSTEM key prime menu.

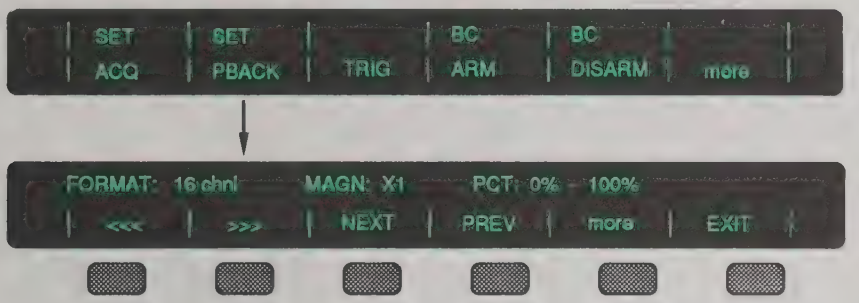
SYSTEM Key Prime Menu: Level 2—

SET PBACK submenus



Pressing the soft key beneath SET PBACK invokes two submenus that define the format of the data capture playback, a magnification factor or compression factor for the waveform, and the percentage of the playback to be printed. Whether the playback will be manual or automatic is also specified in the SET PBACK setup.

SYSTEM Key Prime Menu: Level 2—
SET PBACK submenu 1



<<< or >>> Pressing the soft key beneath either <<< or >>> individually selects each of the three displayed parameters: PCT, MAGN, FORMAT. [>>>] selects from the right. [<<<] selects from the left.

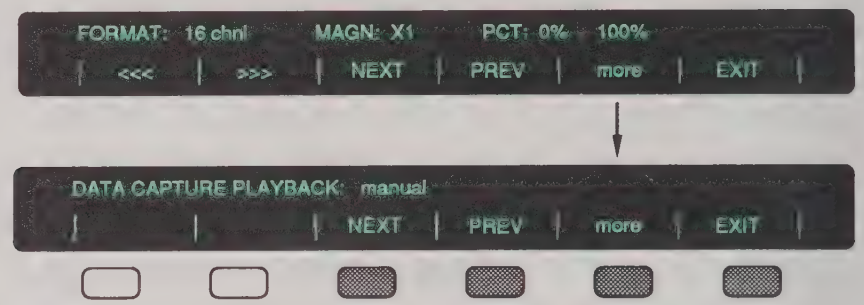
NEXT or PREV Pressing the soft key beneath either NEXT or PREV:

- When FORMAT is the selected parameter, the display scrolls either forward or backward through eight format options: 16 chnl, 16 olap, 8 chnl, 4 chnl, 8 olap, XY plot, numeric, 12 chnl.
- When MAGN is the selected parameter, the display scrolls either forward or backward through seven playback magnification factors: 1/4, 1/2, 1, 2, 4, 8.
- When PCT is the selected parameter, either increases or decreases the playback percentage in 1% increments from 1% to 100%.

more Pressing the soft key beneath "more" invokes SET PBACK submenu 2.

EXIT Pressing the soft key beneath EXIT returns the recorder to Level 2 of the SYSTEM Key prime menu.

SYSTEM Key Prime Menu: Level 2—
SET PBACK submenu 2



Submenu 2 allows you to specify whether captured data will be played back automatically or manually.

NEXT or PREV — Pressing the soft key beneath either NEXT or PREV causes the display to alternate between "manual" and "automatic."

more — Pressing the soft key beneath "more" toggles the display between submenus 1 and 2.

EXIT — Pressing the soft key beneath EXIT toggles the display between submenus 1 and 2.

SYSTEM Key Prime Menu: Level 2—
TRIG submenus

The menus that become available when the TRIG selection is invoked are identical to those of the TRIGGER key. Please refer to the discussion of the TRIGGER key for a full explanation of these menus.

SYSTEM Key Prime Menu: Level 2— BC ARM submenu

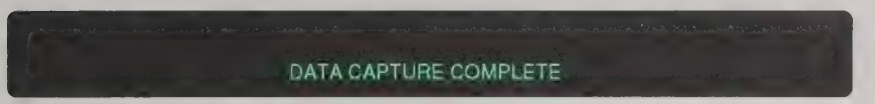
BC ARM Pressing the soft key beneath BC ARM implements background data capture. No front-panel displays result from this selection.

A note on Background Data Capture

This powerful capability allows data acquisition to occur "in the background" without interrupting ongoing real-time recording.

When a background data capture occurs and the DATA CAPTURE PLAYBACK parameter of the SET PBACK setup is set to "auto", the captured data will be played back immediately and automatically.

When a background data capture occurs and the DATA CAPTURE PLAYBACK parameter of the SET PBACK setup is set to "manual", the following display results.



If a data capture occurs when the recorder is operating in a real-time recording mode, the message will remain until the captured data is played back. This ensures that ongoing real-time recording will not be unintentionally interrupted with consequent loss of current real-time data. It also ensures that the captured data will be played out before being replaced by any subsequent data captures.

If a data capture occurs when the recorder is not operating in a real-time recording mode, the display will briefly show the DATA CAPTURE COMPLETE message and will then return to its previous display.

It is important to be aware of the following characteristics of background data capture.

- Background data capture must be armed in order for it to be used during recording.

- If the ACQUISTION ARM menu of the SET ACQ setup is set to automatic rearm ("auto — rearm"), then background data capture is already armed when any real-time recording mode is entered.

- If the ACQUISTION ARM menu of the SET ACQ setup is set to manual rearm ("manual — rearm"), then background data capture is not armed when real-time recording is entered. In this case, you need to arm back ground data capture through the SYSTEM key.

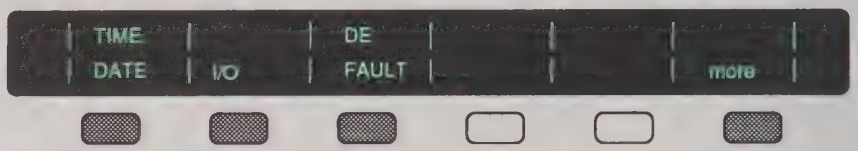
- When BC ARM is selected, data immediately and constantly flows through the circular data-capture memory buffer. Therefore, selecting BC ARM immediately flushes any data already in the buffer. The flushed data is not recoverable.

  To select background data capture when you are recording in real-time (and "manual — rearm" is selected), press the SYSTEM key. This will bring you to the system setup menus without leaving the current recording mode. Proceed through system setup menus until you reach the menu containing BC ARM and BC DISARM. Press the soft key beneath BC ARM to invoke background data capture. After you have pressed the soft key beneath BC ARM, nothing more needs to be done to implement the feature. If a data capture should occur, the data capture activity will take place without interrupting the on-going real-time recording.

- Remember that if you (1) manually select BC ARM, (2) leave the current recording mode, and (3) re-enter the same or any other mode, then background data capture is automatically disarmed. When you leave and re-enter a real-time recording mode, you need to reselect BC ARM to re-activate background data capture.

SYSTEM Key Prime Menu: Level 2— BC DISARM submenu

BC DISARM Pressing the soft key beneath BC DISARM disables the background data capture feature. No front-panel displays result from this selection.



When the soft key beneath "more" in Level 2 of the SYSTEM prime menu is pressed, Level 3 of the prime menu is displayed.

TIME DATE — Pressing the soft key beneath TIME DATE invokes the menu used to set the recorder's clock and calendar.

I/O — Pressing the soft key beneath I/O invokes the menus that define host-control input/output communications parameters and implement down-loading of software upgrades.

DEFAULT — Pressing the soft key beneath DEFAULT invokes the menu that implements default values for any of four recording parameters: channel annotation, zero, numerical, and channel order.

more — Pressing the soft key beneath more invokes Level 4 of the SYSTEM prime menu.

SYSTEM Key Prime Menu: Level 3—
TIME DATE submenu

The TIME DATE submenu is used to set the recorder's real-time clock and calendar.

<<< or >>> Pressing the soft key beneath either <<< or >>> individually selects each digit of the date and time. [>>>] selects from the right. [<<<] selects from the left.

INC Pressing the soft key beneath INC increases the currently selected digit.

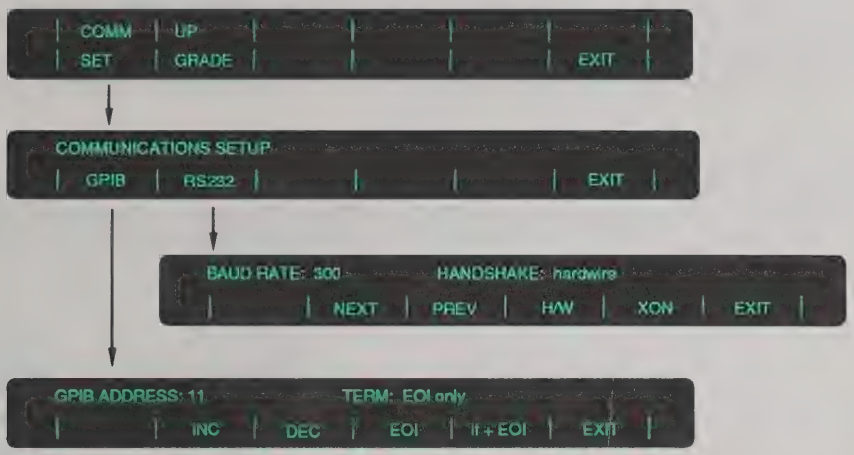
DEC Pressing the soft key beneath DEC decreases the currently selected digit.

EXIT Pressing the soft key beneath EXIT returns the display to Level 3 of the SYSTEM prime menu.

SYSTEM Key Prime Menu: Level 3—

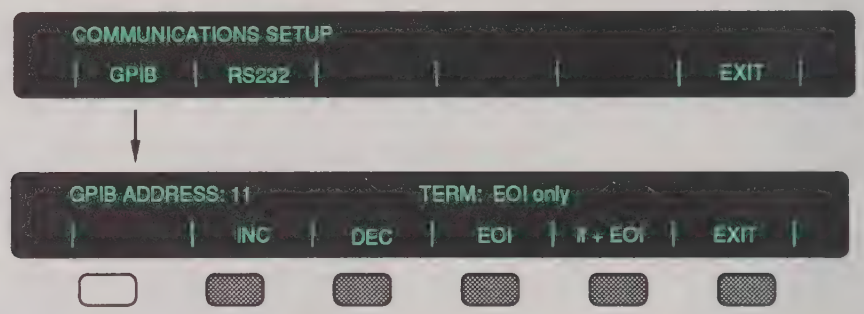
I/O submenus

Pressing the soft key beneath the I/O selection invokes a two-function menu. The COMM SET selection is used to define the communications setup for host control operation. The UPGRADE selection is used to quickly and easily accomplish upgrades to the chart recorder's operating system software. Each of these choices are individually explained on the pages that follow.



The COMM SET setup is used to establish communications with a host computer.

COMM SET Pressing the soft key beneath COMM SET invokes the COMMUNICATIONS SETUP submenu used to implement host communications through either of two communications interface options: GPIB and RS232.



When host control is implemented through the GPIB interface, the GPIB menu specifies a GPIB address and a terminator for all command sequences.

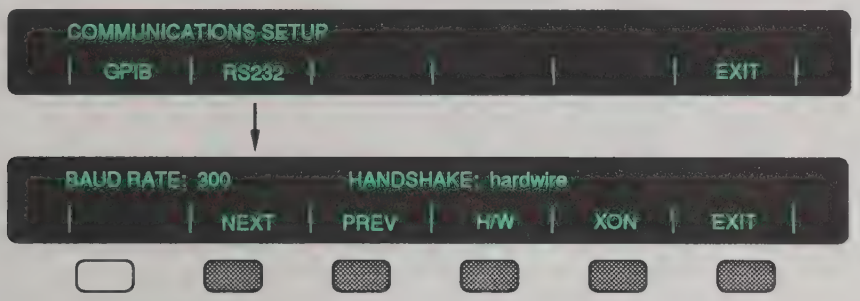
INC Pressing the soft key beneath INC increases the displayed GPIB address to the next higher address number.

DEC Pressing the soft key beneath INC decreases the displayed GPIB address to the next lower address number.

EOI Pressing the soft key beneath EOI (end or identify) affects the displayed TERM parameter by specifying that only an EOI pulse will be recognized as a terminator.

lf + EOI Pressing the soft key beneath lf + EOI affects the displayed TERM parameter by specifying that either an lf (line feed) control character or an EOI pulse will be recognized as a terminator.

EXIT Pressing the soft key beneath EXIT returns the display to the COMMUNICATIONS SETUP submenu.



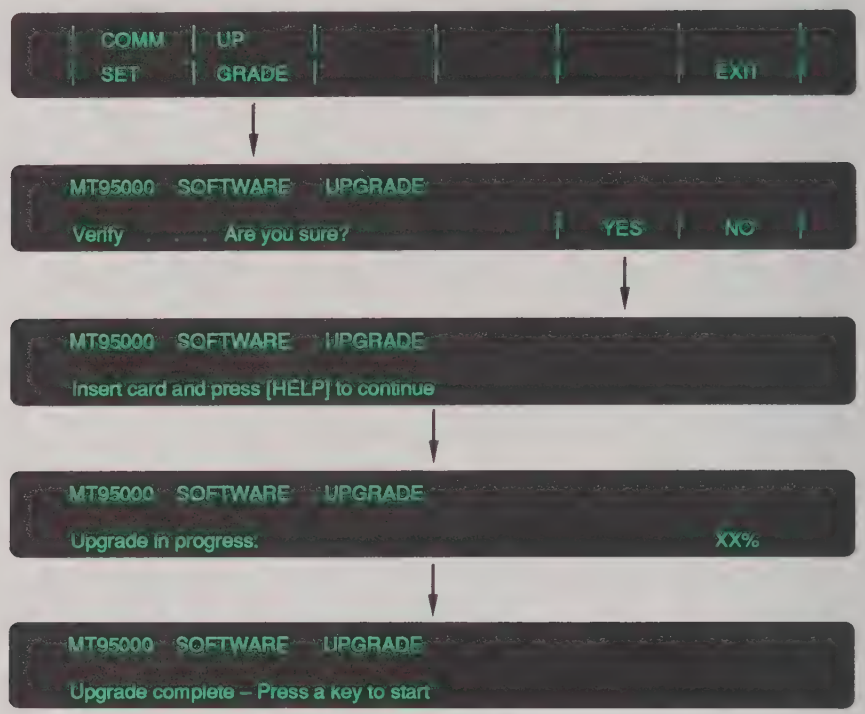
When host control is implemented through the RS232 interface, the RS232 menu specifies a baud rate and handshake method for all communications.

NEXT or PREV Pressing the soft key beneath either NEXT or PREV scrolls either forward (NEXT) or backward (PREV) through six available BAUD RATE settings: 300, 1200, 2400, 4800, 9600, 19,200.

H/W Pressing the soft key beneath H/W affects the displayed HANDSHAKE parameter by specifying that communications control will be implemented via cable (hardwire).

XON Pressing the soft key beneath XON affects the displayed HANDSHAKE parameter by specifying that communications control will be implemented via software instruction. When the soft key is pressed, the HANDSHAKE display reads: Xon/Xoff.

EXIT Pressing the soft key beneath EXIT returns the recorder to the COMMUNICATIONS SETUP display.



The process of upgrading the chart recorder's system software is extremely simple. When UPGRADE has been invoked, you are given a final opportunity to verify your intention of completing the upgrade process. This helps ensure against inadvertent tampering with or changing of the recorder's current operating system.

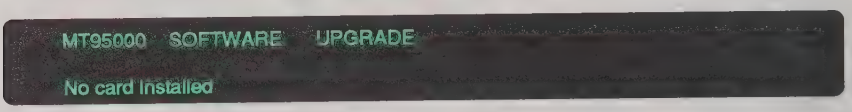
YES Pressing the soft key beneath YES confirms your intention to upgrade operating system software and invokes a message instructing you to insert an Astro-Med system software upgrade card into the rear panel card slot. When you press the [HELP] key, the upgrade is initiated.

As the upgrade is underway, an "Upgrade in progress" message is shown and a dynamic display of the percentage of the upgrade that has been completed appears near the right bottom corner of the display.

A final display tells you when the upgrade has been completed.

NO Pressing the soft key beneath NO cancels the upgrade process and returns the display to the first level of the COMM SET / UPGRADE menu.

If the upgrade installation should fail, any of the following messages may be displayed.



No card installed

This message will appear if an upgrade is attempted without an Astro-Med system software upgrade card inserted in the rear-panel upgrade slot.

Non-system card installed

This message will appear if an upgrade is attempted with any card other than Astro-Med system software upgrade card.

General ROM error

This message will appear if difficulty is encountered reading any ROM chip. If displayed, repeat the down-load process.

Program error

This message will appear if a problem is encountered in reading the new operating system into memory.

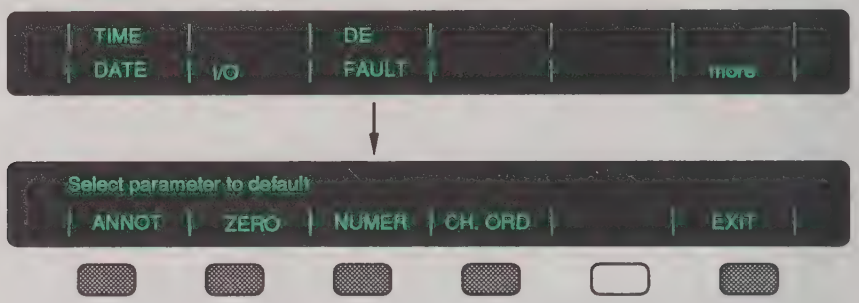
Erase error

This message will appear if a problem is encountered in the process of erasing the operating system currently in ROM.

System software not installed

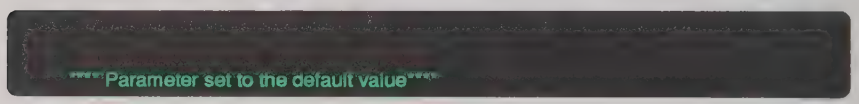
If the attempted installation fails, this message confirms the failed installation. Repeat the installation process.

SYSTEM Key Prime Menu: Level 3— DEFAULT submenu



Pressing the soft key beneath DEFAULT invokes a submenu that allows you to individually reset four setup parameters to their default values. Setting any parameter to its default status affects all of the recorder's channels.

When the soft key beneath any parameter is pressed, the display will show the following message:



ANNOT Pressing the soft key beneath ANNOT causes all channel annotation buffers to contain an alphanumeric channel identifier: CHANNEL 1, CHANNEL 2, etc.

ZERO Pressing the soft key beneath ZERO causes all zero baselines to be centered in their channels.

NUMER Pressing the soft key beneath NUMER causes the left and right edge Datalogger values for all channels to be +200 and -200 E + 0 respectively.

CH. ORDER Pressing the soft key beneath CH. ORDER causes all channels to be printed from left to right across the chart in progressive numerical order.

EXIT Pressing the soft key beneath EXIT returns the display to Level 3 of the SYSTEM key prime menu.

When the soft key beneath "more" in Level 3 of the SYSTEM key prime menu is pressed, Level 4 of the prime menu is displayed.

MOTOR SRC Pressing the soft key beneath MOTOR SRC invkokes the menu that specifies whether motor clock speed control will be internal or external.

INSTA SPDS Pressing the soft key beneath INSTA SPDS invkokes the menu that defines the instantly available speed values for the A, B, and C insta-speed keys of the CHART SPEEDS group.

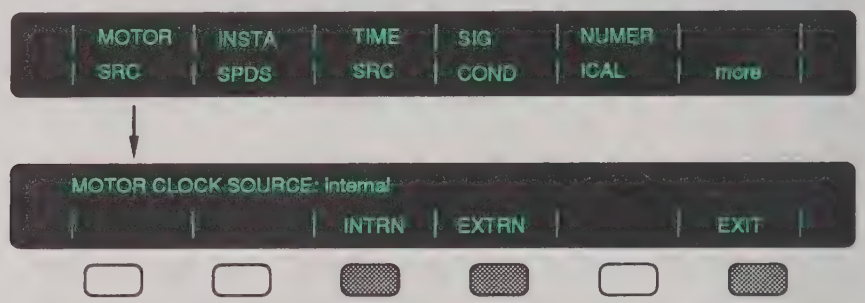
TIME SRC Pressing the soft key beneath TIME SRC invkokes the menu that specifies whether the recorder's time reference will be its internal clock or any of four external time sources.

SIG COND Pressing the soft key beneath SIG COND invokes the menu that, for each channel, specifies whether or not signal conditioner status reporting will be recorded in the associated interchannel buffer.

NUMERICAL Pressing the soft key beneath MOTOR SRC invokes the menu that, when recording in Datalogger mode, specifies the for each channel the conversion factors you desire for the left and right edges of the waveform. These factors are then used to scale waveform data for subsequent printing as tabular numeric data.

more Pressing the soft key beneath "more" returns the display to Level 1 of the SYSTEM key prime menu.

SYSTEM Key Prime Menu: Level 4—
MOTOR SRC submenu



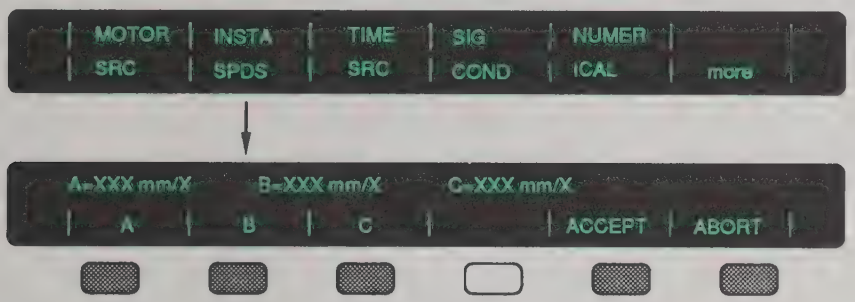
The MOTOR SRC submenu is used to specify whether the speed of the stepper motor clock will be reference to the chart recorder's internal clock or to an external speed source.

INTRN Pressing the soft key beneath INTRN references the stepper motor clock to the recorder's internal clock.

EXTRN Pressing the soft key beneath EXTRN references the stepper motor clock to an external speed source.

EXIT Pressing the soft key beneath EXIT returns the display to the MOTOR SRC submenu.

SYSTEM Key Prime Menu: Level 4—
INSTA SPDS submenu



Pressing the soft key beneath INSTA SPDS invokes the insta-speeds submenu. This submenu is used to program the chart speeds you desire into the A, B, and C insta-speed keys of the CHART SPEEDS group.

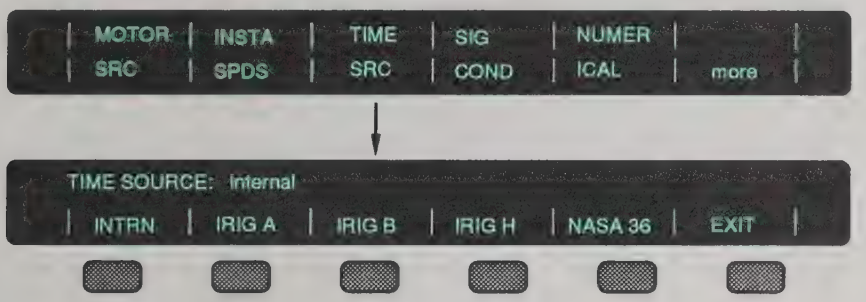
A, B, or C Pressing the soft key beneath A, B, or C selects the first digit of the key's currently displayed speed for editing.

- Use the arrow keys of the alphanumeric keypad to select the remaining digits of the displayed speed. The right arrow selects digits to the right. The left arrow selects to the left.
- Use the number keys of the alphanumeric keypad to change the selected (blinking) digit.
- Use the MM/SEC, MM/MIN, MM/HR keys of the CHART SPEEDS group to change the displayed speed range.
- If you press one of the fixed speed keys (1, 5, ... 200) of the CHART SPEEDS group when you are programming the A, B, C keys, the selected insta-speed key immediately takes on the value of the fixed speed key. This makes the insta-key redundant to the fixed speed key.

ACCEPT When you have finished defining the insta-speeds you desire, press the soft key beneath ACCEPT. This causes the recorder to accept and implement the new insta-speeds. When the soft key beneath ACCEPT is pressed, the display returns to the MOTOR SRC menu.

ABORT Pressing the soft key beneath ABORT instructs the recorder to disregard any ongoing reprogramming of the insta-speed keys and returns the display to the MOTOR SRC menu.

SYSTEM Key Prime Menu: Level 4—
TIME SRC submenu



Pressing the soft key beneath TIME SRC invokes the TIME SOURCE submenu. This menu allows you to specific one of five possible sources for the recorder's time reference.

INTRN Pressing the soft key beneath INTRN sets the recorder's time reference to its internal clock. The word "internal" appears opposite TIME SOURCE in the display indicating the selected setting.

IRIG A Pressing the soft key beneath IRIG A sets the recorder's time reference to an externally generated IRIG A time pulse. "IRIG A" appears opposite TIME SOURCE in the display indicating the selected setting.

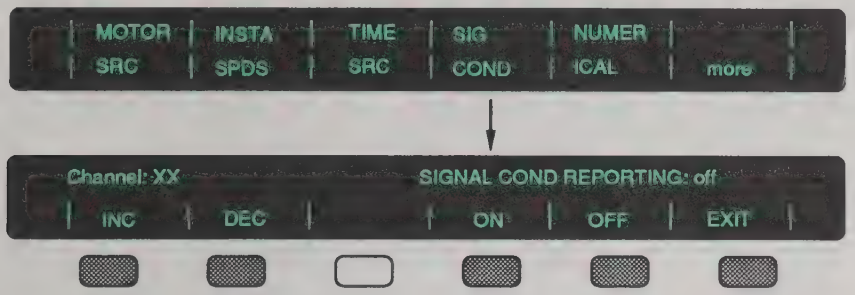
IRIG B Pressing the soft key beneath IRIG B sets the recorder's time reference to an externally generated IRIG B time pulse. "IRIG B" appears opposite TIME SOURCE in the display indicating the selected setting.

IRIG H Pressing the soft key beneath IRIG H sets the recorder's time reference to an externally generated IRIG H time pulse. "IRIG H" appears opposite TIME SOURCE in the display indicating the selected setting.

NASA 36 Pressing the soft key beneath NASA 36 sets the recorder's time reference to an externally generated NASA 36 time pulse. "NASA 36" appears opposite TIME SOURCE in the display indicating the selected setting.

EXIT Pressing the soft key beneath EXIT returns the display to the Level 4 of the prime menu.

SYSTEM Key Prime Menu: Level 4— SIG COND submenu



Pressing the soft key beneath SIG COND invokes the signal conditioner status reporting menu. For each individual channel, this menu is used to implement or suppress printing of signal conditioner status reporting in the selected interchannel annotation buffer.

INC Pressing the soft key beneath INC increases the number of the displayed channel selection to the next higher channel number. This selects the next higher channel. The INC selection affects only the channel number parameter.

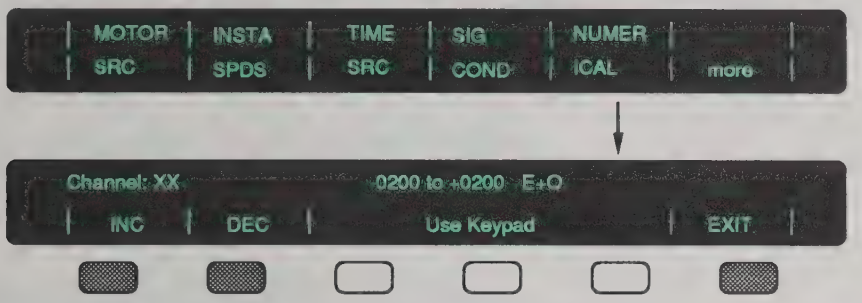
DEC Pressing the soft key beneath DEC decreases the number of the displayed channel selection to the next lower channel number. This selects the next lower channel. The DEC selection affects only the channel number parameter.

ON Pressing the soft key beneath ON implements printing of signal conditioner status reporting in the currently selected channel's interchannel annotation buffer.

OFF Pressing the soft key beneath OFF suppresses printing of signal conditioner status reporting in the currently selected channel's interchannel annotation buffer.

EXIT Pressing the soft key beneath EXIT returns the display to the Level 4 of the prime menu.

SYSTEM Key Prime Menu: Level 4— NUMERICAL submenu



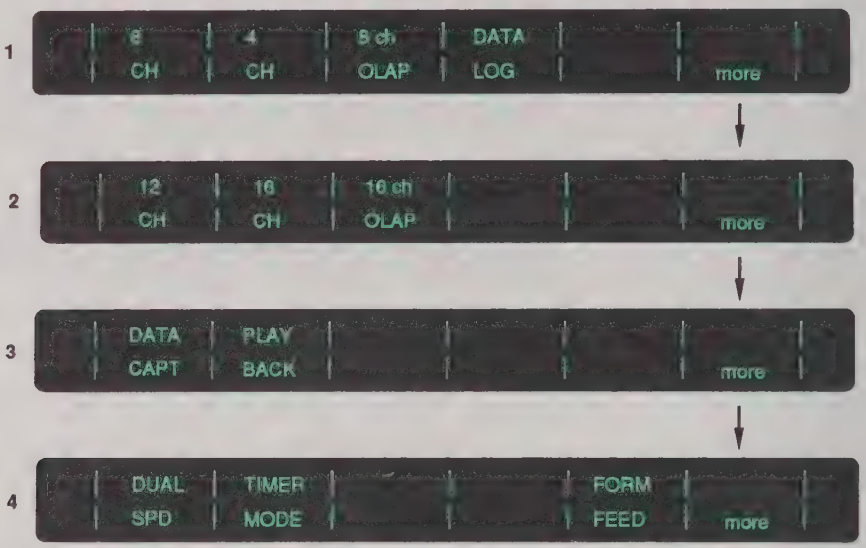
Pressing the soft key beneath NUMERICAL invokes the menu used to specify the conversion factors used when recording in the Datalogger mode. The conversion factors represent the values of the left and right edges of the waveform in the selected channel. These values are used to convert the waveform data into tabular numeric columns of data. The editable parameters of this display include the channel number, the left and right edge values, and an exponent value (E) which is constrained to whole numbers from -4 to +4.

INC Pressing the soft key beneath INC increases the selected channel to the next higher channel number.

DEC Pressing the soft key beneath DEC decreases the selected channel to the next lower channel number.

When the NUMERICAL submenu is invoked, the first element (+ or -) of the conversion factors is already blinking indicating that it is selected and can be changed. Use the alphanumeric keypad to change the left- and right-edge values. As each digit is changed, the adjoining digit is automatically selected for change.

EXIT EXIT returns the display to Level 1 prime menu.



Depending upon the configuration of your chart recorder, a maximum of 12 modes are accessed using the MODE key. This discussion is based on a recorder with 16 channels and all software options.

Pressing the MODE key invokes the first of four displays that comprise the MODE prime menu. For clarity, each display is considered a level of the prime menu and is discussed as Level 1, Level 2, etc.

MODE Key Prime Menu: Level 1

When the MODE key is pressed, Level 1 of the MODE key prime menu is displayed.

8 CH Pressing the soft key beneath 8 CH immediately enters the recorder into 8-channel real-time recording. Recording reflects either custom presets defined using the SYSTEM key or default presets if default values have not been changed.

4 CH Pressing the soft key beneath 4 CH immediately enters the recorder into 4-channel real-time recording. Recording reflects either custom presets defined using the SYSTEM key or default presets if default values have not been changed.

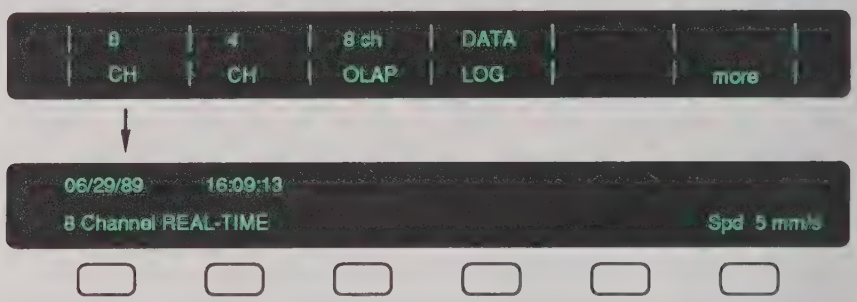
8 ch OLAP Pressing the soft key beneath 8 ch olap immediately enters the recorder into 8-channel overlapped real-time recording. Recording reflects either custom presets defined using the SYSTEM key or default presets.

DATALOG Pressing the soft key beneath DATALOG immediately enters the recorder into Datalogger operation reflecting the values specified in the NUMERICAL setup of the SYSTEM key.

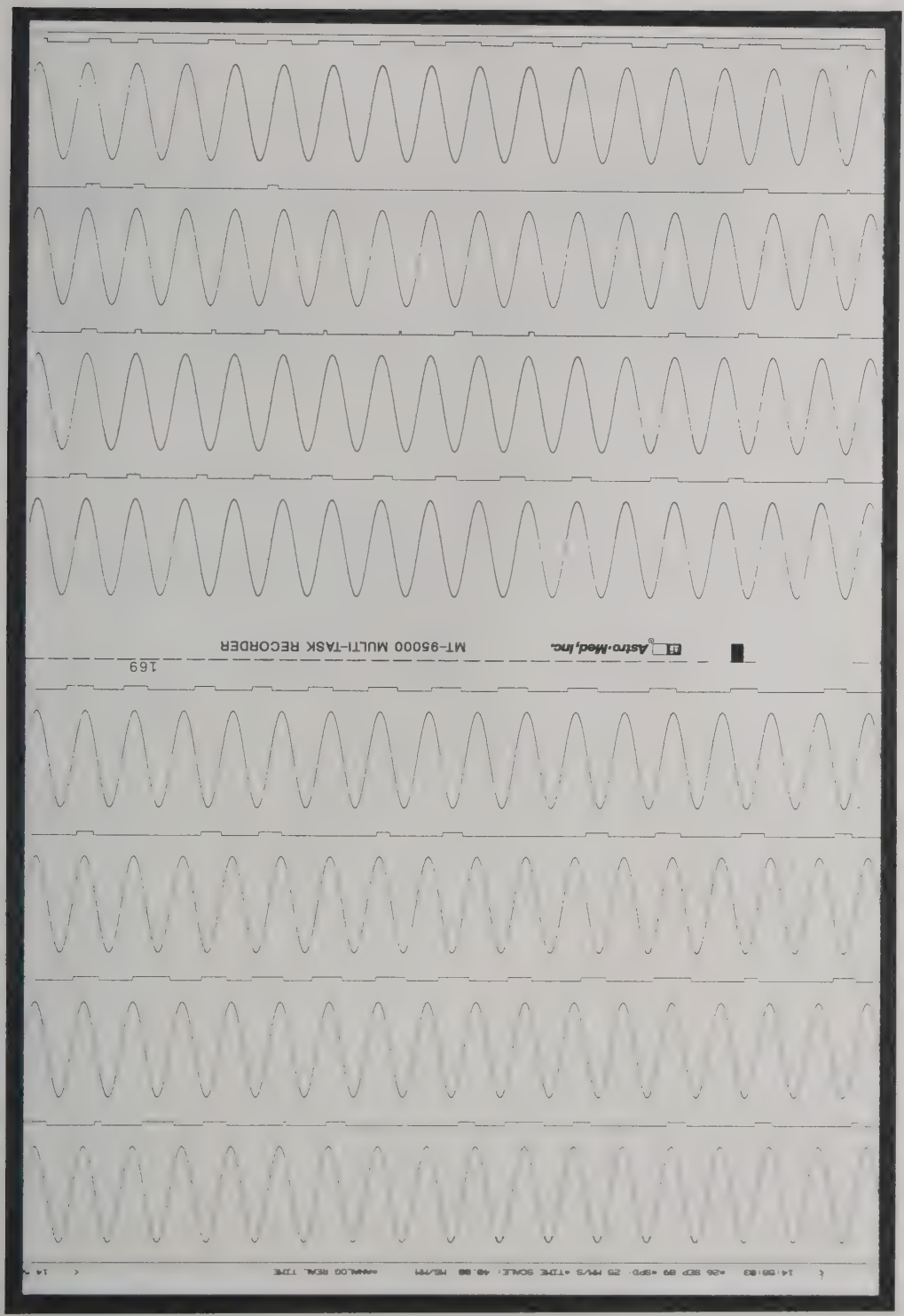
more Pressing the soft key beneath "more" invokes Level 2 of the MODE key prime menu.

MODE Key Prime Menu: Level 1—

8 CH Mode display



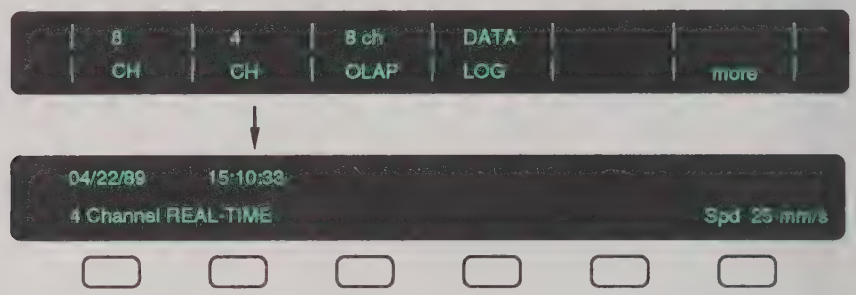
Pressing the soft key beneath 8 CH immediately enters the recorder into 8-channel real-time recording and invokes the 8 Channel REAL-TIME display. The top line of the display shows the current date and time. The time display is dynamic showing the changing second, minute, and hour values. When recording is halted, *HALTED* appears in the upper right corner of the display. The lower line of the display shows the name of the mode and the current chart paper speed.



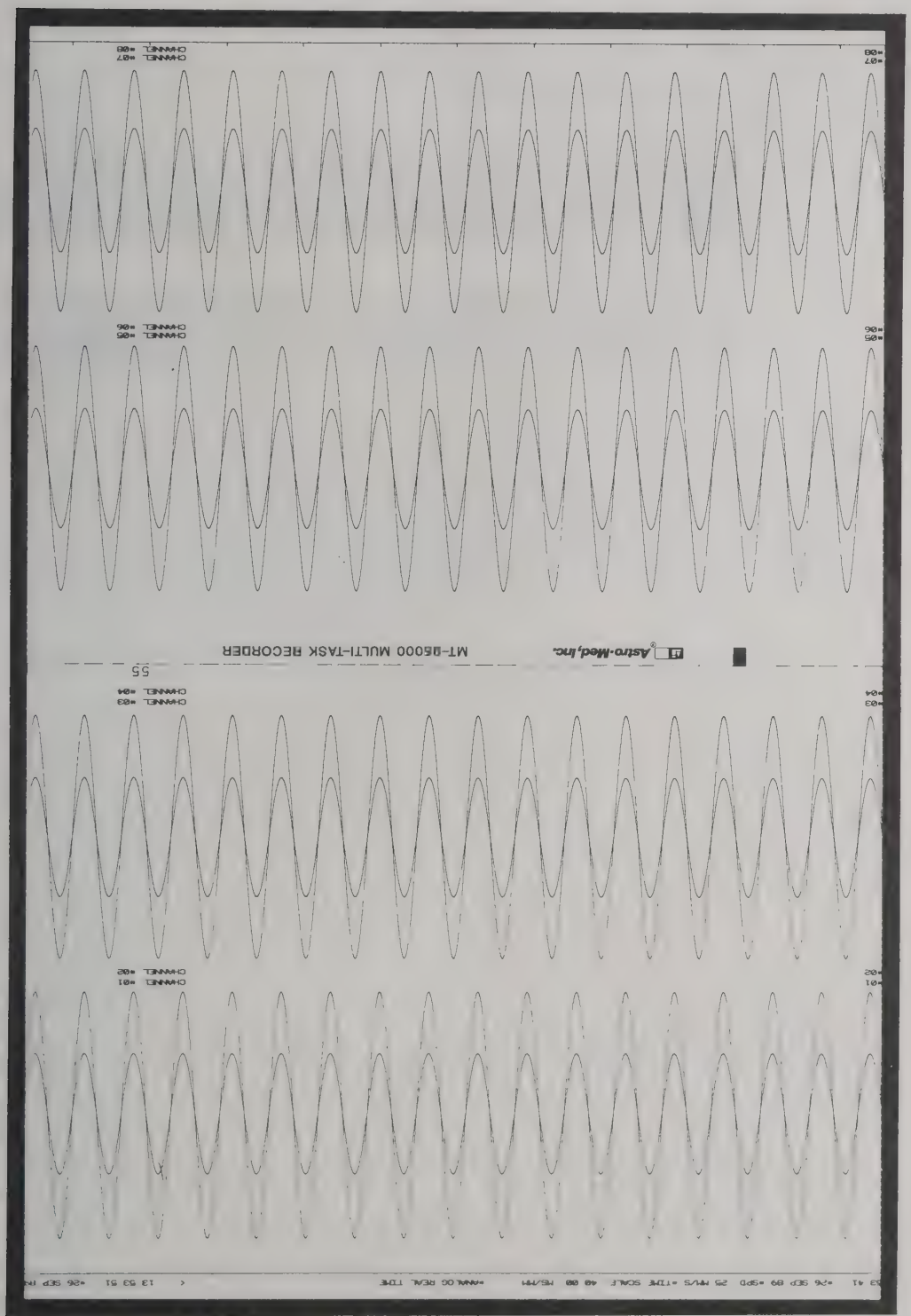
8 Channel Real-Time Recording Showing Event Marker Activity

MODE Key Prime Menu: Level 1—

4 CH Mode display



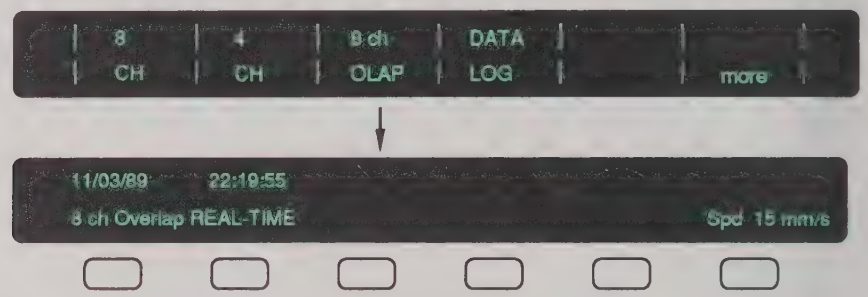
Pressing the soft key beneath 4 CH immediately enters the recorder into 4-channel real-time recording and invokes the 4 Channel REAL-TIME display. The top line of the display shows the current date and time. The time display is dynamic showing the changing second, minute, and hour values. When recording is halted, *HALTED* appears in the upper right corner of the display. The lower line of the display shows the name of the mode and the current chart paper speed.



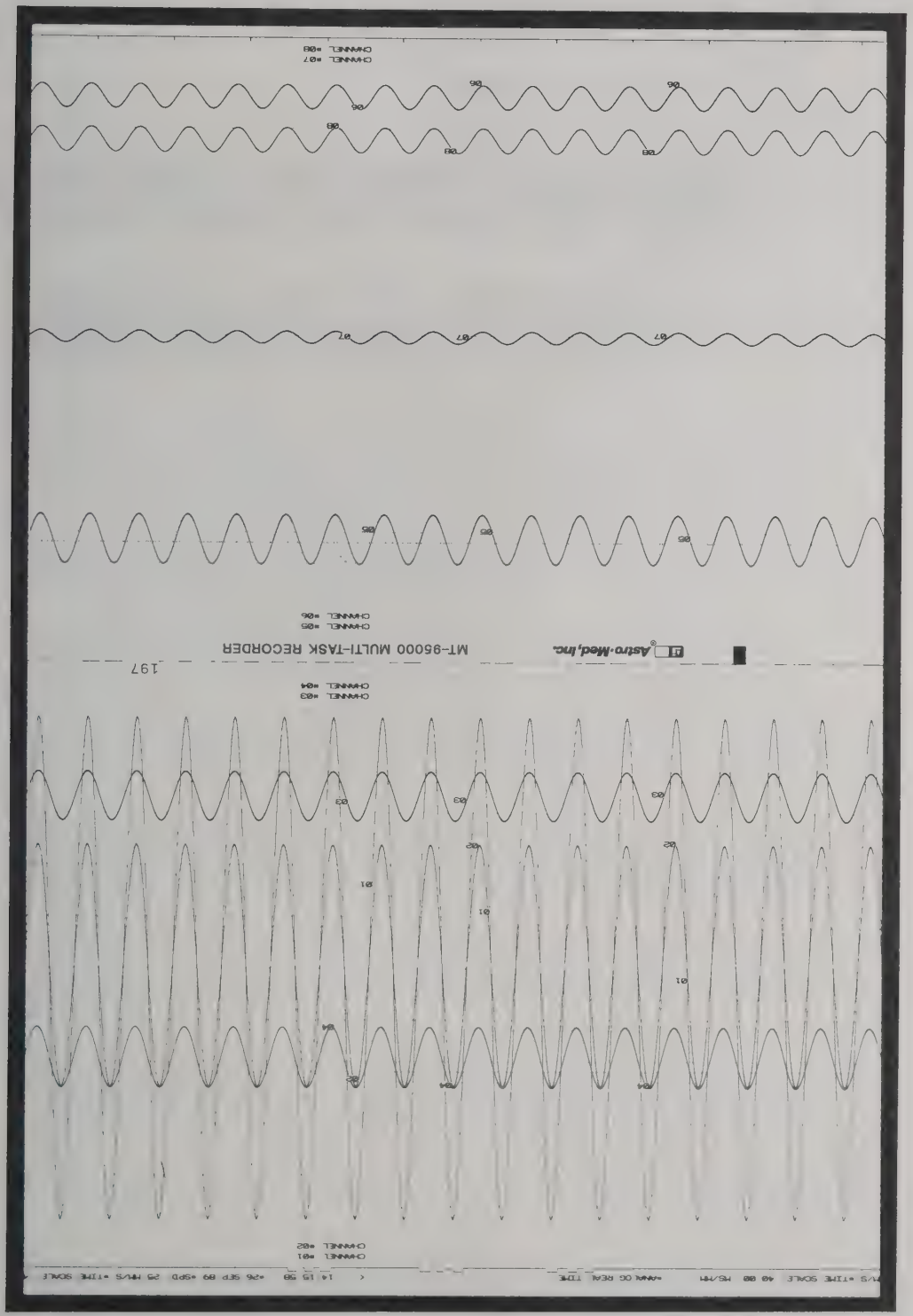
4 Channel Real-Time Recording: Two Waveforms Overlapped in Four Channels

MODE Key Prime Menu: Level 1—

8 ch OLAP Mode display



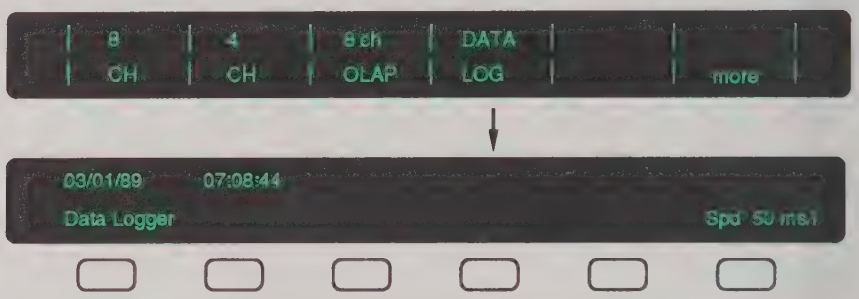
Pressing the soft key beneath 8 ch OLAP immediately enters the recorder into 8-channel overlap real-time recording and invokes the 8 ch Overlap REAL-TIME display. The top line of the display shows the current date and time. The time display is dynamic showing the changing second, minute, and hour values. When recording is halted, *HALTED* appears in the upper right corner of the display. The lower line of the display shows the name of the mode and the current chart paper speed.



8 Channel Ovelap Real-Time Recording With System Event Marker Toggling and Channel ID Indicators

MODE Key Prime Menu: Level 1—

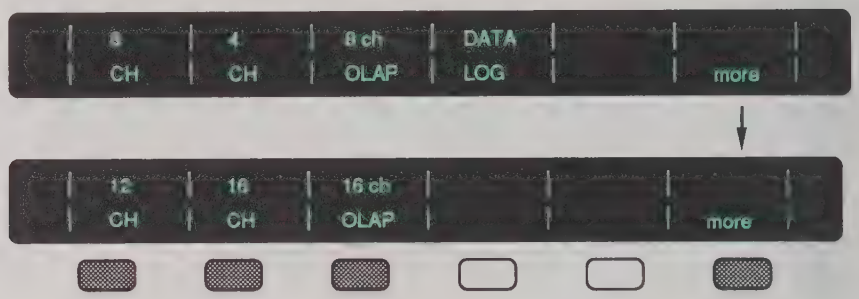
DATALOG Mode display



Pressing the soft key beneath DATA LOG immediately enters the recorder into Datalogger real-time recording and invokes the Datalogger display. The top line of the display shows the current date and time. The time display is dynamic showing the changing second, minute, and hour values. When recording is halted, *HALTED* appears in the upper right corner of the display. The lower line of the display shows the name of the mode and the current chart paper speed in milliseconds/, seconds/, or minutes per line.

MT-95000 MULTI-TASK RECORDER
Astro-Med, Inc.
** REAL TIME DATA ** ** SAMPLE PERIOD: 175 ms ** ** DATE: 26 SEP 89 **
CHANNEL # 1
CHANNEL # 2
CHANNEL # 3
CHANNEL # 4
CHANNEL # 5
CHANNEL # 6
CHANNEL # 7
CHANNEL # 8
14:16:43
14:16:40
14:16:37
14:16:35
14:16:32

MODE Key Prime Menu: Level 2



When the soft key beneath "more" in Level 1 of MODE key prime menu is pressed, Level 2 of the prime menu is displayed.

If your recorder is configured as a 12-channel system, Level 2 of the Mode Key prime menu will display a 12-channel overlap option.

12 CH Pressing the soft key beneath 12 CH immediately enters the recorder into 12-channel real-time recording. Recording reflects either presets defined using the SYSTEM key or default presets.

16 CH Pressing the soft key beneath 16 CH immediately enters the recorder into 16-channel real-time recording. Recording reflects either presets defined using the SYSTEM key or default presets.

16 ch OLAP Pressing the soft key beneath 16 ch OLAP immediately enters the recorder into 16-channel overlapped real-time recording. Recording reflects either presets defined using the SYSTEM key or default presets.

more Pressing the soft key beneath "more" invokes Level 3 of the MODE key prime menu.

MODE Key Prime Menu: Level 2—

12 CH Mode display

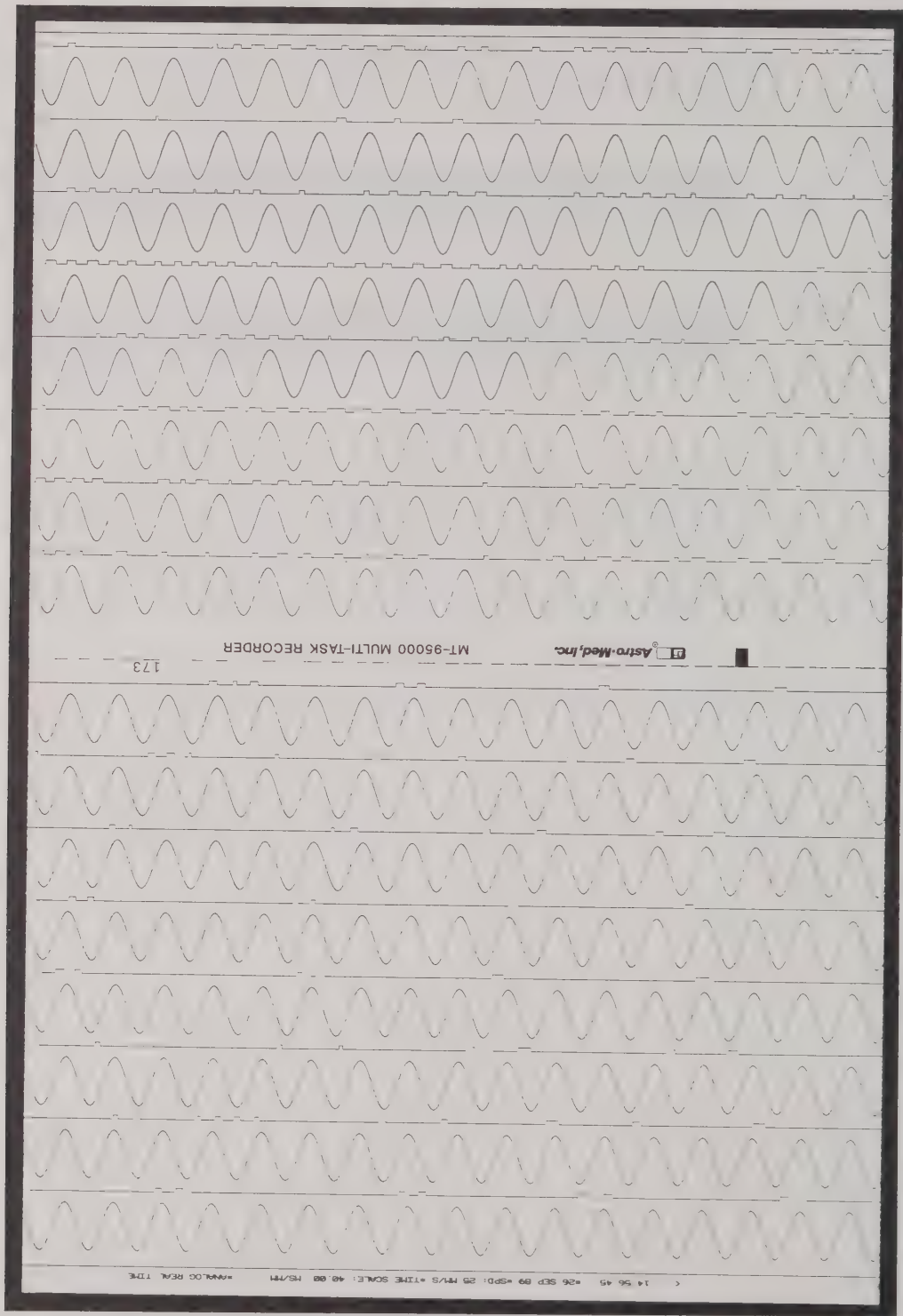
Pressing the soft key beneath 12 CH immediately enters the recorder into 12-channel real-time recording and invokes the 12 Channel REAL-TIME display. The top line of the display shows the current date and time. The time display is dynamic showing the changing second, minute, and hour values. When recording is halted, *HALTED* appears in the upper right corner of the display. The lower line of the display shows the name of the mode and the current chart paper speed.

12 Channel Real-Time Recording With System Log

MODE Key Prime Menu: Level 2—

16 CH Mode display

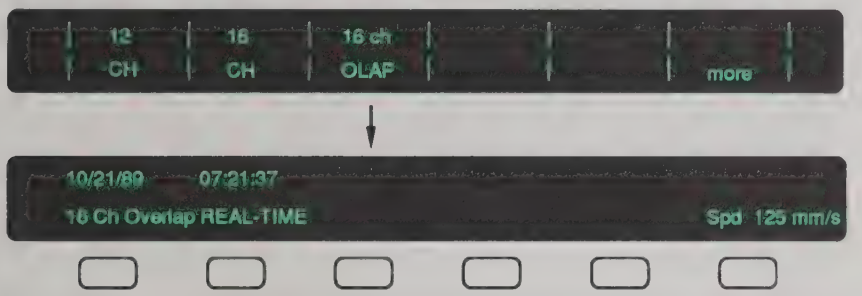
Pressing the soft key beneath 16 CH immediately enters the recorder into 16-channel real-time recording and invokes the 16 Channel REAL-TIME display. The top line of the display shows the current date and time. The time display is dynamic showing the changing second, minute, and hour values. When recording is halted, *HALTED* appears in the upper right corner of the display. The lower line of the display shows the name of the mode and the current chart paper speed.



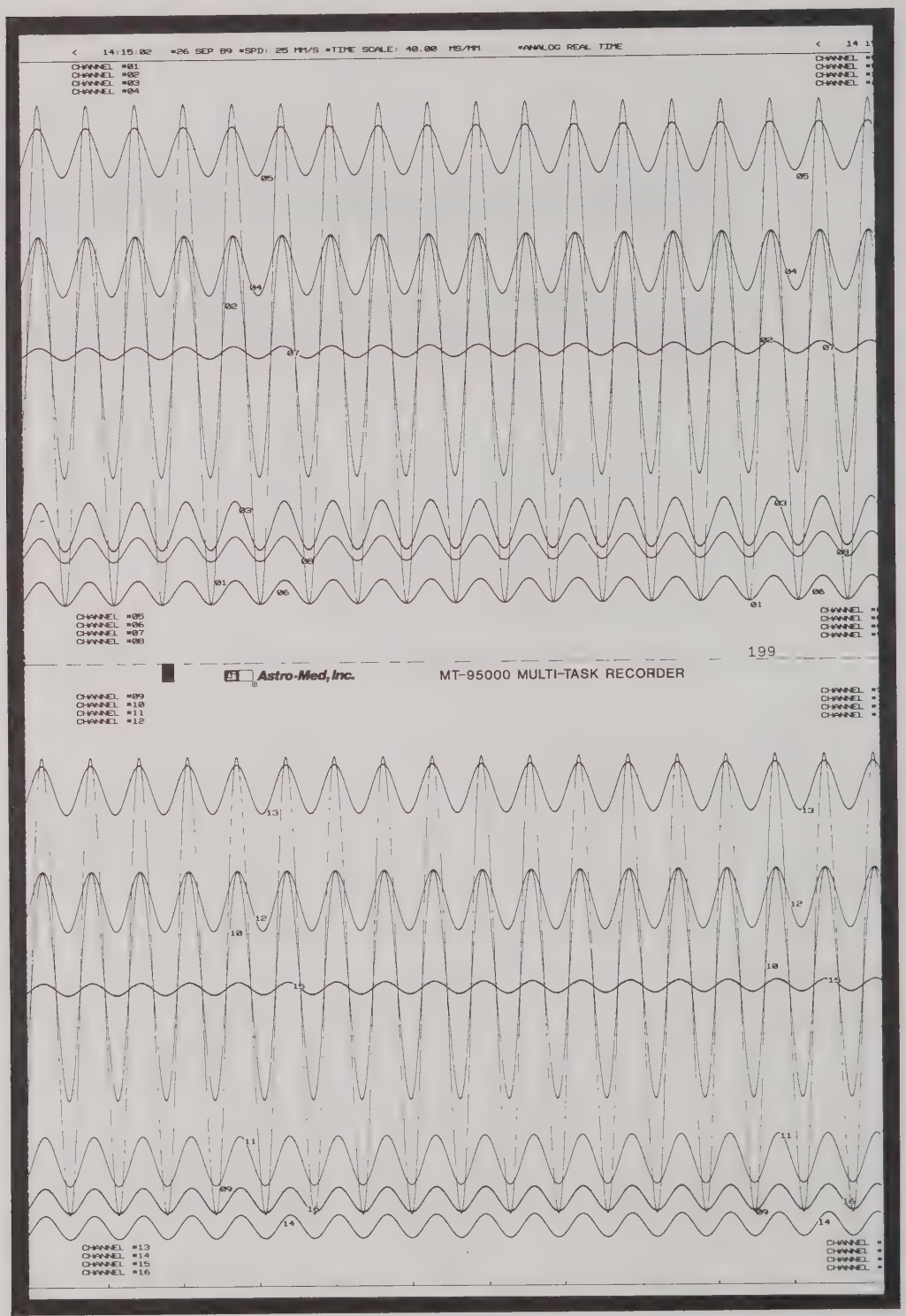
16 Channel Real-Time Recording With Event Markers

MODE Key Prime Menu: Level 2—

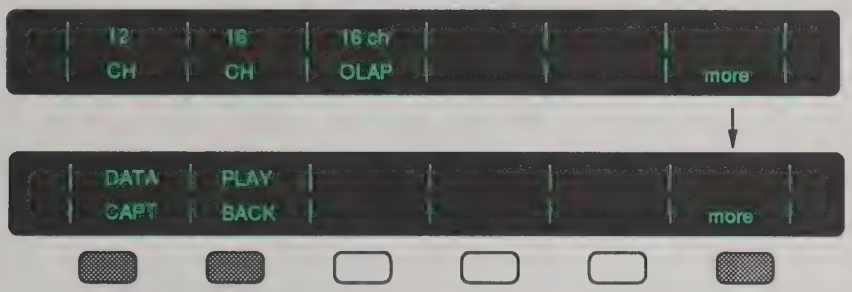
16 ch OLAP Mode display



Pressing the soft key beneath 16 ch OLAP immediately enters the recorder into 16-channel overlap real-time recording and invokes the 16 Ch Overlap REAL-TIME display. The top line of the display shows the current date and time. The time display is dynamic showing the changing second, minute, and hour values. When recording is halted, *HALTED* appears in the upper right corner of the display. The lower line of the display shows the name of the mode and the current chart paper speed.



16 Channel Overlap Real-Time Recording With Channel ID Markers



When the soft key beneath "more" in Level 2 of MODE key prime menu is pressed, Level 3 of the prime menu is displayed.

DATA CAPT Pressing the soft key beneath DATA CAPT invokes the menu that initiates the data capture mode. The capture reflects either custom presets defined using the SET ACQ menus of SYSTEM key or default presets.

PLAYBACK Pressing the soft key beneath PLAY BACK immediately initiates playback of a data capture acquisition. The playback reflects either custom presets defined using the SET PBACK menus of the SYSTEM key or default presets.

more Pressing the soft key beneath "more" invokes Level 4 of the MODE key prime menu.

MODE Key Prime Menu: Level 3—
DATA CAPT submenus

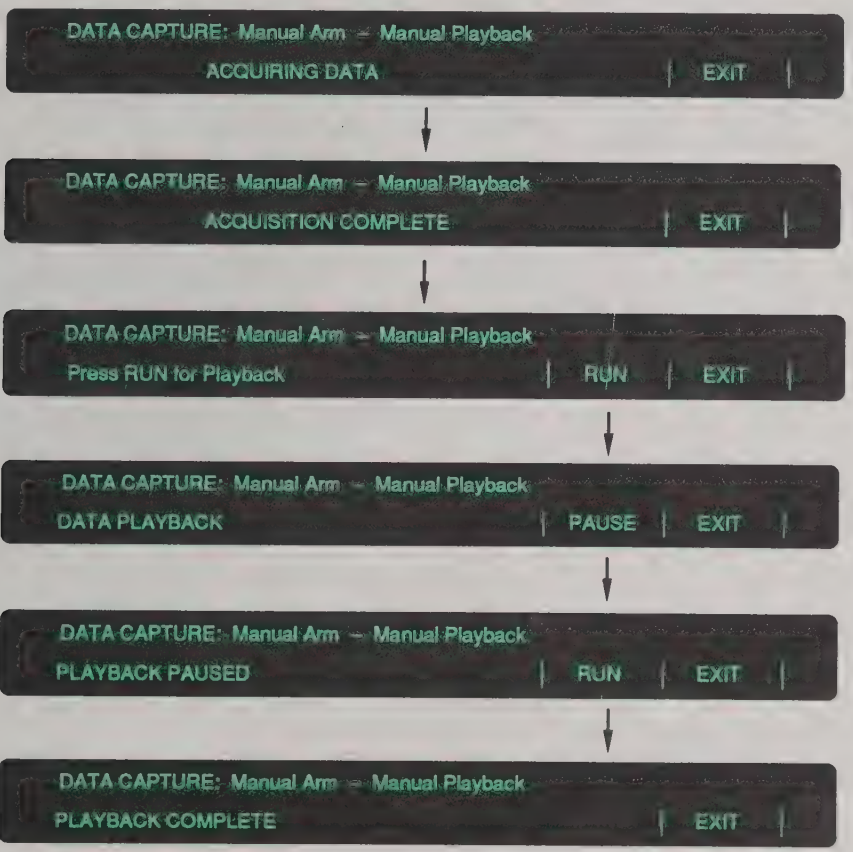
Pressing the soft key beneath DATA CAPT invokes the menu that initiates a data acquisition. The top line of the menu displays the rearm preference defined in the SET ACQ setup of the SYSTEM key. Trigger rearm can either be manual or automatic. The top line also displays the playback preference defined in the SET PBACK setup of the SYSTEM key. Playback can either be manual or automatic.

manual playback option

RUN Pressing the soft key beneath RUN initiates the acquisition of pre-trigger data and results in a message display indicating such acquisition. This message will remain until a manual or automatic trigger is sensed or until the soft key beneath EXIT is pressed.

EXIT Pressing the soft key beneath EXIT aborts the acquisition and returns the recorder to its base display.

manual playback display sequence



Manual playback of an acquisition and automatic playback of an acquisition result in slightly different playback message sequences. If manual playback has been specified, the above menu sequence is observed.

manual playback option (continued)

If the recorder senses a trigger while in the ACQUIRING DATA state, after the capture has been completed, the display will automatically indicate ACQUISITION COMPLETE. If you do not want to proceed, press the soft key beneath EXIT to return to the recorder's base display.

Because this is the manual playback option, the display proceeds to a menu that prompts you to "Press RUN for Playback". Press the soft key beneath RUN to initiate the playback. Press the soft key beneath EXIT to return to the recorder's base display.

When the playback has been initiated, the display will change and present you with an option to pause the playout of the captured data. Press the soft key beneath PAUSE to temporarily halt the playout of the captured data. If you do not want to proceed, press the soft key beneath EXIT to return to the recorder's base display.

If the playback has been paused, the display will change to present you with the option of continuing the playback. Press the soft key beneath RUN to resume the playout. If you do not want to proceed, press the soft key beneath EXIT to return to the recorder's base display.

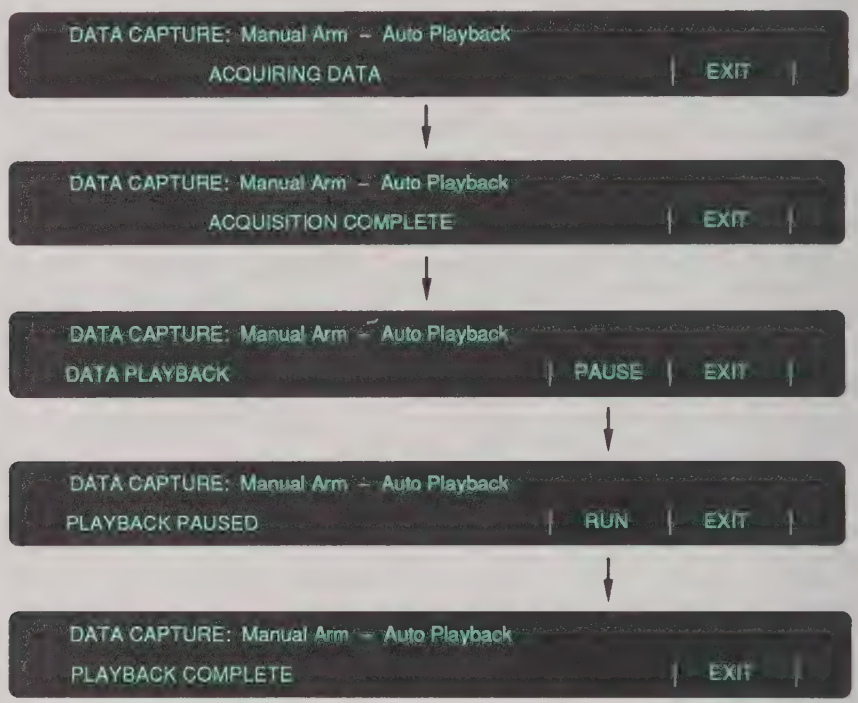
The display automatically informs you when the playback has been completed. Press the soft key beneath EXIT to return to the recorder's base display.

auto playback option

RUN Pressing the soft key beneath RUN initiates the acquisition of pre-trigger data and results in a message display indicating such acquisition. This message will remain until a manual or automatic trigger is sensed or until the soft key beneath EXIT is pressed.

EXIT Pressing the soft key beneath EXIT aborts the acquisition and returns the recorder to its base display.

auto playback display sequence



If automatic playback has been specified, you will observe the message sequence shown above.

auto playback option (continued)

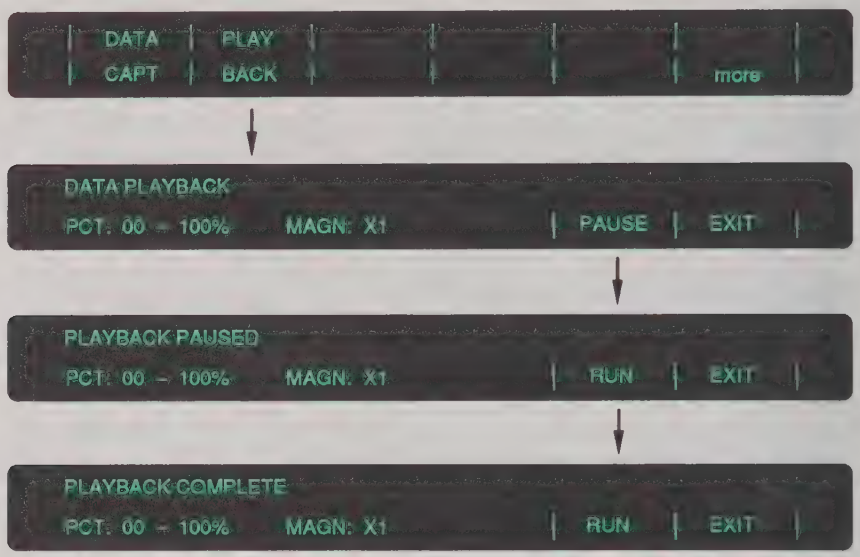
If the recorder senses a trigger while in the ACQUIRING DATA state, the display will automatically indicate that data has been captured by showing ACQUISITION COMPLETE. If you do not want to proceed, press the soft key beneath EXIT to return to the recorder's base display.

Because this is the automatic playback option, data playback is initiated automatically after the acquisition has been completed. The DATA PLAYBACK display is shown while the playout is underway. Press the soft key beneath PAUSE if you want to temporarily halt the playout. If you do not want to proceed, press the soft key beneath EXIT to return to the recorder's base display.

If the playback has been paused, the display will change to present you with the option of continuing the playback. Press the soft key beneath RUN to resume the playout. If you do not want to proceed, press the soft key beneath EXIT to return to the recorder's base display.

The display automatically informs you when the playback has been completed. Press the soft key beneath EXIT to return to the recorder's base display.

MODE Key Prime Menu: Level 3— PLAYBACK Mode submenus



Pressing the soft key beneath PLAYBACK immediately initiates playback of captured data. When the PLAYBACK mode is invoked, data playback is automatic and the above menu sequence is observed.

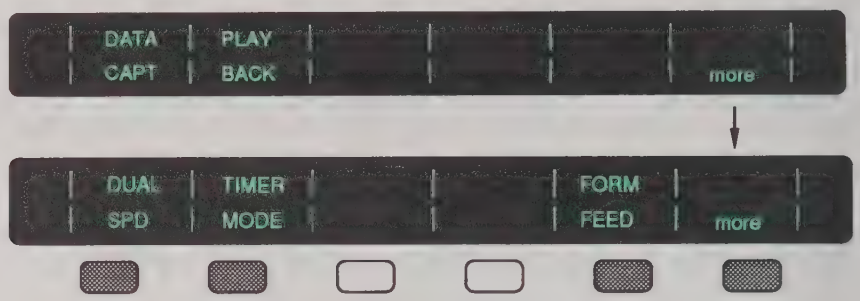
Each menu of the sequence displays the percentage of the acquisition that is being being played out and the magnification factor applied to the playback data. These parameters are defined in the SET PBACK setup.

PAUSE Pressing the soft key beneath PAUSE in the DATA PLAYBACK display temporarily halts the playout and causes the display to change to PLAYBACK PAUSED.

RUN Pressing the soft key beneath RUN in the PLAYBACK PAUSED menu resumes printing of the playback. When the playback has finished, the PLAYBACK COMPLETE display is automatically shown.

RUN Pressing the soft key beneath RUN in the PLAYBACK COMPLETE menu causes an automatic repetition of the same data playback.

EXIT Pressing the soft key beneath EXIT in the any of the PLAYBACK submenus returns the menu to the recorder's base display.



Pressing the soft key beneath "more" in Level 3 of the Mode Key prime menu, invokes Level 4 of the Mode Key prime menu.

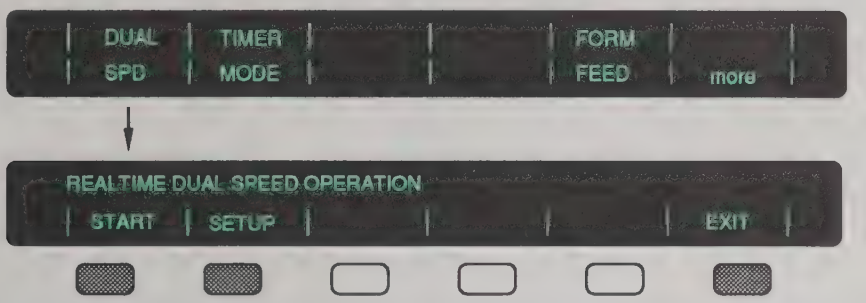
DUAL SPD Pressing the soft key beneath DUAL SPD invokes the menus that enter the recorder into either timed dual speed operation, triggered dual speed operation, or a combination of both.

TIMER MODE Pressing the soft key beneath TIMER MODE invokes the menus that enter the recorder into timed operation.

FORMFEED Pressing the soft key beneath FORM FEED advances the chart paper to the registration mark at the top of the next page.

more Pressing the soft key beneath "more" returns the recorder to Level 1 of the MODE key prime menu.

MODE Key Prime Menu: Level 4—
DUAL SPD Mode submenus



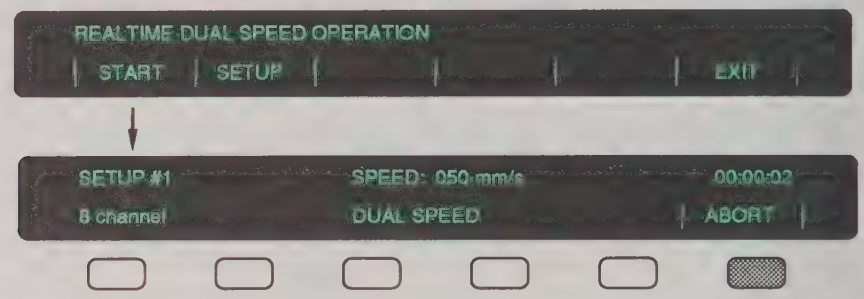
Pressing the soft key beneath DUAL SPD invokes the REAL-TIME DUAL SPEED OPERATION menu. This menu offers two options: START and SETUP.

START Pressing the soft key beneath START immediately initiates dual speed recording. Recording will reflect all current dual speed parameter settings as defined in the SETUP submenus.

SETUP Pressing the soft key beneath SETUP provides access to the menus required to define dual speed parameters.

EXIT Pressing the soft key beneath EXIT returns the recorder to its base display.

MODE Key Prime Menu: Level 4—
DUAL SPD START submenu



Pressing the soft key beneath START in the REALTIME DUAL SPEED OPERATION menu immediately initiates dual speed recording and invokes a display indicating the current setup for SPEED 1 or SPEED 2.

SETUP #1 indicates a combination of (1) speed and (2) duration or trigger as they have been defined for SPEED 1 in the SETUP submenus. These parameters are shown in the top line of the display.

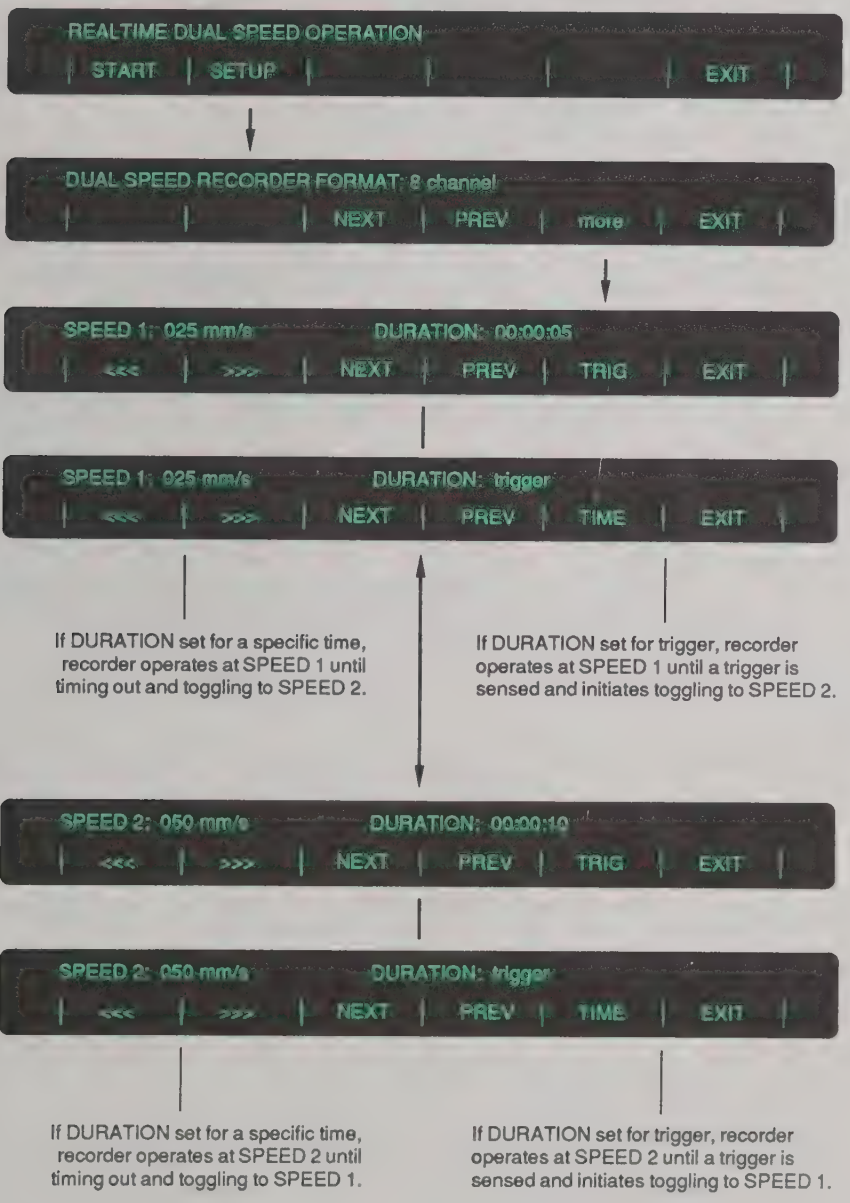
- If a time duration is shown in the right hand corner of the display, the recorder will operate at the listed speed until the duration times out and the recorder toggles to SETUP #2.
- If "trigger" is shown in the right hand corner of the display, the recorder will operate at the listed speed until a predefined trigger is sensed and the recorder toggles to SETUP #2.

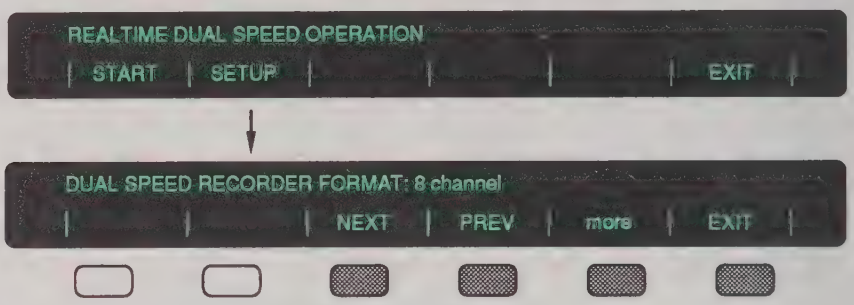
If SETUP #2 is displayed, operation is identical except that the recorder toggles to SETUP #1 upon time-out or when a trigger is sensed.

ABORT Pressing the soft key beneath ABORT returns the recorder to its base display.

MODE Key Prime Menu: Level 4—

DUAL SPD SETUP submenus



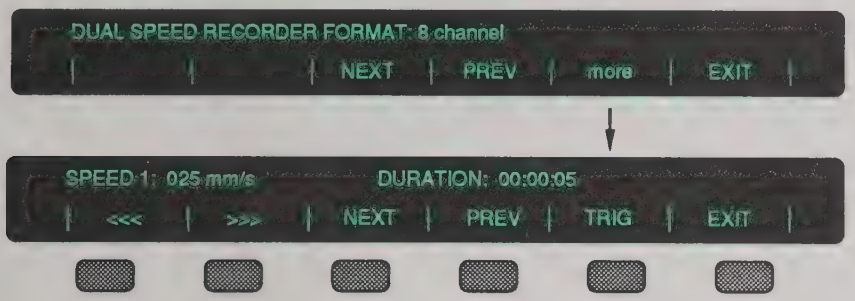


Pressing the soft key beneath SETUP initially invokes the menu used to specify a format for the real-time data.

NEXT or PREV — Pressing the soft keys beneath either NEXT or PREV scrolls either forward or backward through the available format options: 4 channel, 8 channel, 8 ch olap, 12 channel, 16 channel, 16 ch olap.

more — Pressing the soft key beneath "more" invokes menus that allow you to define (1) the two speeds which the recorder will toggle between and (2) the condition that will prompt the toggle activity. The recorder will toggle as a result of either the time-out of predefined time duration or the sensing of a predefined trigger.

EXIT — Pressing the soft key beneath EXIT causes the recorder to return to the REALTIME DUAL SPEED OPERATION display.



Pressing the soft key beneath "more" in the DUAL SPEED RECORDER FORMAT menu invokes a submenu that allows you to:

- specify the recorder's base speed (SPEED 1) in mm/s, mm/min, or mm/hr.
- specify the alternative speed (SPEED 2) to which the recorder will toggle after SPEED 1 times out or encounters a trigger.
- specify whether SPEED 1 will:

  "countdown" for a prescribed duration of time before toggling to SPEED 2, or

  wait for a predefined trigger before toggling to SPEED 2.
- specify whether SPEED 2 will:

  "countdown" for a prescribed duration of time before toggling to SPEED 1, or

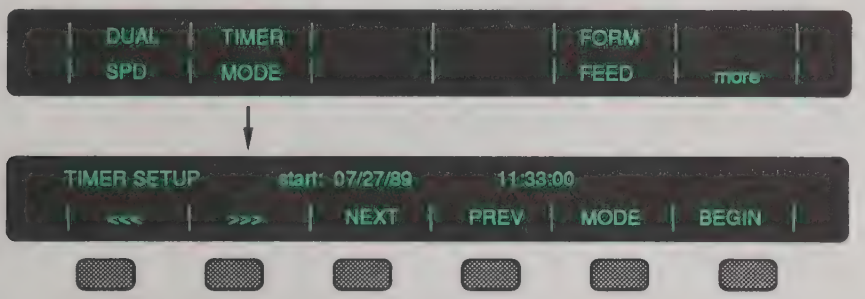
  wait for a predefined trigger before toggling to SPEED 1.

<<< or >>> Pressing the soft key beneath <<< or >>> individually selects each DURATION digit, each SPEED X digit, and the digit that specifies whether SPEED X will be 1 or 2. [<<<] selects each digit from the left. [>>>] selects each digit from the right. As each digit is selected, it blinks indicating that it can be changed.

NEXT or PREV When the SPEED X digit is selected, pressing the soft keys beneath NEXT or PREV changes the digit alternately from 1 to 2.

When any speed digit is selected, use the alphanumeric keypad to enter the numbers you want. Use the MM/SEC, MM/MIN, and MM/HR keys of the CHART SPEEDS group to set the desired range.

When the digits opposite DURATION are selected, pressing the NEXT or PREV keys selects the next higher or lower number. The first numeric pair represents hours. This parameter can be set between 0 and 23. The second numeric pair is minutes and the third is seconds. These parameters can be set between 0 and 59.



Pressing the soft key beneath TIMER MODE invokes the TIMER SETUP menu. The TIMER SETUP menu and its submenus enable the recorder to operate automatically between a predefined start time and end time.

<<< or >>> Pressing the soft key beneath <<< or >>> scrolls through the time, date, and start/stop parameters. [<<<] selects from the left. [>>>] selects from the right. As each parameter is selected, it blinks indicating that it can be changed.

NEXT or PREV

Pressing the soft key beneath NEXT or PREV:

- when the start/stop parameter is selected, alternates between "start" and "stop." "start" indicates that the displayed date and time are when recording will initiate. "stop" indicates that the displayed date and time are when recording will cease.
- when the month, day, or year numeric pair of the date parameter is selected, changes the numeric pair to the next higher or lower digit. If "start" is indicated in the display, this will be the start date. If "stop" is indicated in the display, this will be the stop date.
- when the second, minute, or hour numeric pair is selected, changes the numeric pair to the next higher or lower digit. If "start" is indicated in the display, this will be the start time. If "stop" is indicated in the display, this will be the stop time.

MODE

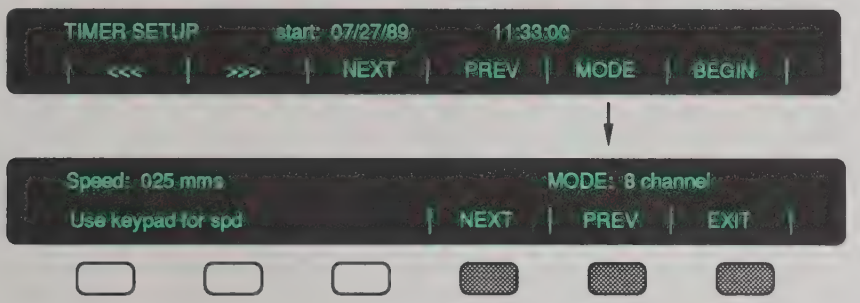
Pressing the soft key beneath MODE invokes the menu used to select a recording mode and chart paper speed.

BEGIN

Pressing the soft key beneath BEGIN enters the recorder into timed operation and invokes a display indicating that the MT-95000/MT-96000 is in the TIMER MODE.

MODE Key Prime Menu: Level 4—

TIMER SETUP submenu / mode soft key



Pressing the soft key beneath MODE in the TIMER SETUP submenu invokes the menu used to choose the recording format in which waveform data will be presented when recording in the TIMER mode.

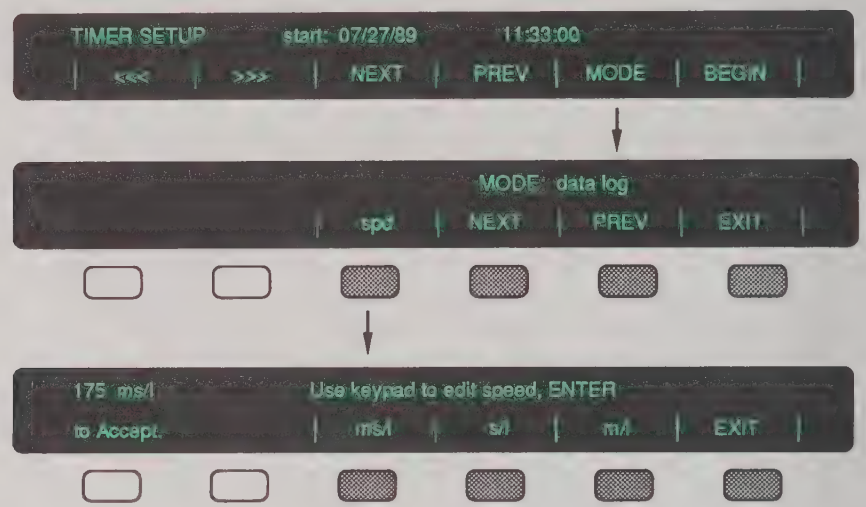
NEXT or PREV Pressing the soft key beneath either NEXT or PREV changes the recording format parameter shown opposite MODE in the display's top line. As either key is pressed, the available recording formats are shown: datalog, 8 ch olap, 4 channel, 8 channel, 16 ch olap, 16 channel, 12 channel.

As each format option is shown, the currently set chart paper speed for that format is shown in the top left corner of the display. The first digit of the speed is automatically selected and blinking indicating that it can be changed. Use the number keys of the alphanumeric keypad to enter a different digit. When one digit is changed, the next digit is automatically selected for change. In this way, any legitimate speed can be implemented for the selected mode.

EXIT Pressing the soft key beneath EXIT returns the recorder to the TIMER SETUP display.

MODE Key Prime Menu: Level 4—

TIMER SETUP submenu / mode soft key - datalog



In the Datalogger mode, the sample period determines how frequently waveform data is printed. For example, a sample period of 175 ms indicates that a line of data is printed every 175 milliseconds (175 ms/line). This contrasts with all other modes which print in terms of millimeters per unit of time. As a result, the menu required for timed operation in the Datalogger mode is slightly different from that required by the other recording formats.

spd When "data log" is the selected mode, pressing the soft key beneath "spd" invokes the menu used to select a printing speed in milliseconds/line, seconds/line, and minutes/line. The currently set speed appears in the display's upper left corner. The first digit of the speed automatically blinks indicating that it is selected and can be changed. Use the number keys of the alphanumeric keypad to change the selected digit. When a digit has been changed, the next number is automatically selected for change.

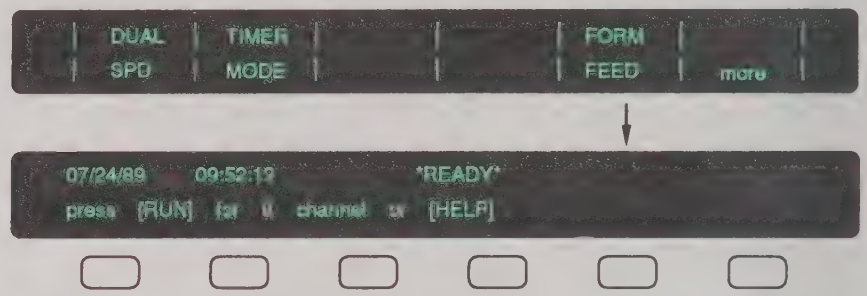
- Pressing the soft key beneath ms/l causes datalogger data to be printed at a rate measured in milliseconds per line.
- Pressing the soft key beneath s/l causes datalogger data to be printed at a rate measured in seconds per line.
- Pressing the soft key beneath m/l causes datalogger data to be printed at a rate measured in minutes per line.

NEXT or PREV Pressing the soft key beneath either NEXT or PREV changes the recording format parameter shown opposite MODE in the display's top line. As either key is pressed, the available recording formats are shown: datalog, 8 ch olap, 4 channel, 8 channel, 16 ch olap, 16 channel, 12 channel.

EXIT Pressing the soft key beneath either EXIT in either of the datalog submenus returns the recorder to the TIMER SETUP display.

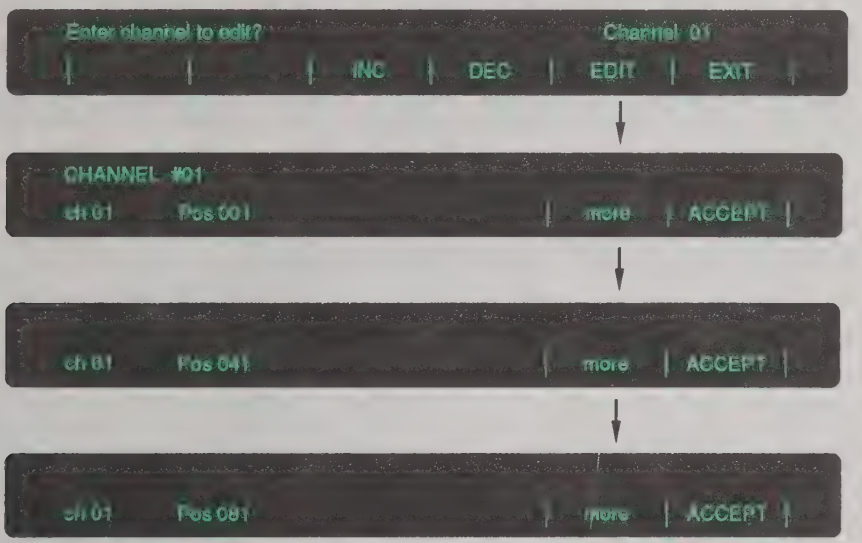
MODE Key Prime Menu: Level 4—

FORMFEED Mode



Pressing the soft key beneath FORM FEED immediately causes the recorder to advance the chart paper to the next Top-of-Form index mark. The recorder's display changes to the base display.

EDIT Key displays



The EDIT key is used to select an interchannel buffer and edit the contents of the buffer. Each interchannel buffer is 120-characters in length. Use the EDIT key to enter the alphanumeric information of your choice to be printed in the buffer.

EDIT Key displays select channel submenu

Pressing the EDIT key invokes the menus required (1) to select an interchannel annotation buffer for editing and (2) to edit the content of the buffer.

INC Pressing the soft key beneath INC changes the channel number associated with the buffer to be edited to the next higher channel number. The channel number parameter is automatically selected and blinking when the EDIT key is pressed. This indicates that it is ready to be changed.

DEC Pressing the soft key beneath DEC changes the channel number associated with the buffer to be edited to the next lower channel number.

EDIT Pressing the soft key beneath EDIT invokes the menu required to access any space within the 120-character interchannel buffer and enter or delete information in that space.

EXIT Pressing the soft key beneath EXIT returns the recorder to the "Enter channel" menu.

Pressing the soft key beneath EDIT causes the menu listing the first forty characters of the interchannel buffer to be displayed. The current contents of the buffer will be listed across the top level of the display. The first character of the display is automatically selected and blinking. This indicates that it can be changed.

The bottom level of the display indicates the number of the channel associated with the interchannel buffer being displayed. The "Pos" (position) parameter indicates the number of the interchannel buffer space (001 - 120) currently selected.

Use the alphanumeric keypad to enter the characters of your choice in the buffer.

- The right arrow key of the alphanumeric keypad moves to the right through each space of the displayed interchannel content selecting each character for change.
- The left arrow key of the alphanumeric keypad moves to the left through each space of the displayed interchannel content selecting each character for change.
- The DEL key of the alphanumeric keypad deletes any currently character. If the DEL key is pressed and held, any currently selected character and all characters to its right will be deleted.
- The INS key allows you to select any position from within the buffer and insert data from that point.

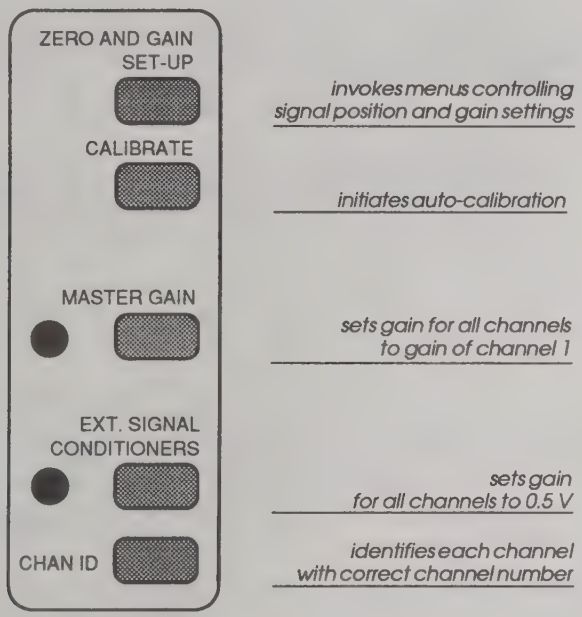
more

Pressing the soft key beneath "more" calls up the next 40-character spaces of the interchannel buffer.

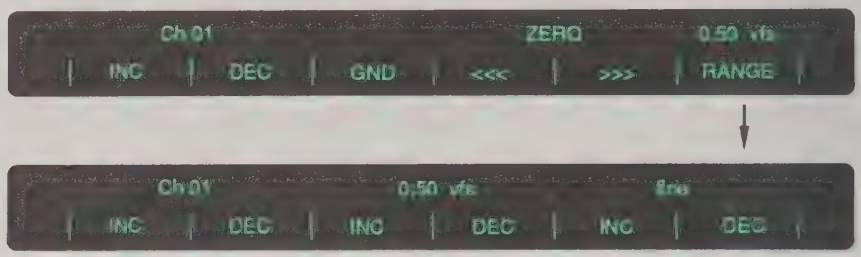
ACCEPT

Pressing the soft key beneath ACCEPT causes the recorder to accept the edited interchannel buffer content. This content will be printed on the chart when the annotation option is selected for the particular buffer. If you do not press ACCEPT, no change will be made to the current content of the buffer.

CHANNEL Group


ZERO AND GAIN SET-UP
invokes menus controlling signal position and gain settings
CALIBRATE
initiates auto-calibration
MASTER GAIN
sets gain for all channels to gain of channel 1
EXT. SIGNAL CONDITIONERS
sets gain for all channels to 0.5 V
CHAN ID
identifies each channel with correct channel number

The CHANNEL group consists of the following keys: ZERO AND GAIN SET-UP, CALIBRATE, MASTER GAIN, EXT. SIGNAL CONDITIONERS, and CHAN ID. These keys provide a variety of signal position and gain controls. The function of each key is described on the pages that follow.



The ZERO AND GAIN SET-UP key invokes the menus required to:

- select a channel to be adjusted
- ground or accept the channel's input signal
- position the waveform within the channel
- set the channel's full scale voltage input range.

initial submenu

INC Pressing the soft key beneath INC increases the displayed channel number to the next higher number.

DEC Pressing the soft key beneath DEC decreases the displayed channel number to the next lower number.

GND Pressing the soft key beneath GND either grounds the input signal or accepts it. When the signal has been grounded, GND regularly blinks.

<<< or >>> Pressing the soft key beneath <<< or >>> shifts the zero baseline to the left or right within the channel. [<<<] shifts the base line to the left. [>>>] shifts the baseline to the right.

RANGE Pressing the soft key beneath RANGE invokes the menu required to set and fine tune the channel's full scale voltage.

- If the MASTER GAIN control is active, the RANGE parameter will only appear when channel 1 is being adjusted. This is because the MASTER GAIN control sets all channels to the values specified for channel 1.

- If the EXT. SIGNAL CONDITIONERS control is active, the RANGE parameter will not appear at all. This is because the EXT. SIGNAL CONDITIONERS control sets the full scale voltage for all channels to 0.5 volts to accommodate the requirements of the external signal conditioners.

INC or DEC

For the **channel parameter (Ch XX)**, pressing the soft key beneath INC increases the displayed channel number to the next higher number. DEC decreases the displayed channel number to the next lower number. The channel number shown is the channel that is being adjusted.

For the **volts-full-scale parameter (vfs)**, pressing the soft key beneath either INC or DEC scrolls through the MT-95000's eight fixed full scale voltage settings: 0.50 vfs, 1.00 vfs, 2.00 vfs, 4.00 vfs, 5.00 vfs, 10.00 vfs, 20.00 vfs, 40.00 vfs.

For the **fine tuning parameter (fine)**, pressing the soft key beneath INC or DEC increases or decreases the volts-full-scale setting. Fine tuning the full scale voltage alters the calibration relationship between the full scale voltage and the grid causing the calibration of the resulting recordings to be less accurate. This is indicated by the appearance of the word "uncal" in the display when fine tuning is used.

CALIBRATE Key

Pressing the CALIBRATE key causes the recorder to perform an automatic and extremely accurate gain self-calibration procedure. The self-calibration procedure tests and corrects the baseline offset for each range and channel.

If recording is ongoing:

- waveform output is interrupted briefly.
- the calibration process is performed.
- the chart is annotated with the ground reference and calibration factor for each channel.
- the interrupted recording resumes.

MASTER GAIN Key

Pressing the MASTER GAIN key sets the gain of all channels to that of channel 1. When the MASTER GAIN key is invoked, its associated LED lights and remains illuminated until the key is pressed a second time releasing the setting. When the MASTER GAIN key is being used, the RANGE setting of the ZERO AND GAIN SET-UP menu will only be available when adjusting the parameters of channel 1.

EXT. SIGNAL CONDITIONERS Key

Pressing the EXT. SIGNAL CONDITIONERS key of the MT-95000/MT-96000:

- allows the recorder to accept status reporting from any of Astro-Med's ASC-900 or ASC-950 series signal conditioners.
- sets the gain of each channel to 0.5 vfs to ensure compatibility between the external signal conditioners and the recorder.

When the EXT. SIGNAL CONDITIONERS key is invoked, its associated LED lights and remains illuminated until the key is pressed a second time releasing the setting. When the EXT. SIGNAL CONDITIONERS key is being used, the RANGE setting of the ZERO AND GAIN SET-UP menu is not available.

CHAN ID Key

When the recorder is operating in any non-overlapped real-time mode and the CHAN ID key is pressed, a channel identification number is immediately printed in each channel. The digit that is printed is the number of the channel. This feature is especially helpful if the channels have been rearranged and are no longer in numerical order.

When the recorder is operating in an overlapped mode and the CHAN ID key is pressed, a channel identification number is immediately printed on each waveform. The digit that is printed is the number of the channel. The value of this feature in identifying overlapped data is obvious.

BASIC RECORDER RUN Key

begins immediate recording

Pressing the BASIC RECORDER RUN key causes the recorder to immediately enter either 8-, 12-, or 16-channel real-time recording depending on the configuration of your recording system. Recording setups will reflect the most recently defined settings.

Operation Group

halts / resumes recorder operation

prints three status sheets

toggles system event marker

causes a manual trigger

Each of the Operation Group's four keys has an immediate affect on ongoing recorder operations. The functions of each key are discussed on the pages that follow.

START / STOP Key

Pressing the START / STOP key halts and re-initiates recorder printing. Use the START / STOP key when you want to pause the recorder.

HELP Key

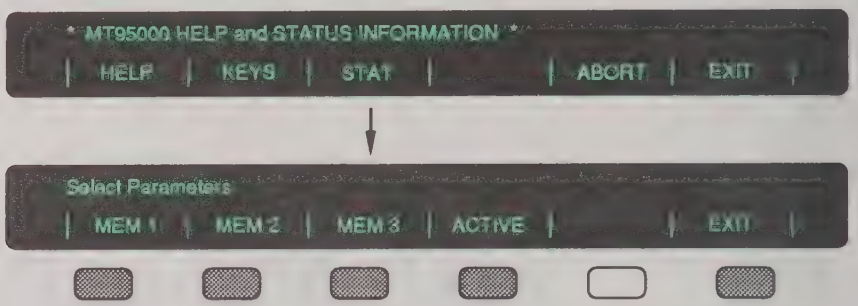
HELP Pressing the soft key beneath HELP results in the immediate printing of a QUICK START GUIDE TO OPERATION.

KEYS Pressing the soft key beneath KEYS results in the immediate printing of a GENERAL KEYPAD INFORMATION sheet.

STAT Pressing the soft key beneath STAT invokes the menu used to specify printout of current system setup parameters or the parameters of any of the three system setups stored in the RECALL Group's MEM keys.

ABORT Pressing the soft key beneath ABORT immediately stops the printout of any ongoing HELP or status sheet information.

EXIT Pressing the soft key beneath EXIT returns the recorder to its base display.



MEM 1 Pressing the soft key beneath MEM 1 results in the immediate printing of a STATUS REPORT listing the system setup settings for the MEM 1 key of the RECALL group.

MEM 2 Pressing the soft key beneath MEM 2 results in the immediate printing of a STATUS REPORT listing the system setup settings for the MEM 2 key of the RECALL group.

MEM 3 Pressing the soft key beneath MEM 3 results in the immediate printing of a STATUS REPORT listing the system setup settings for the MEM 3 key of the RECALL group.

ACTIVE Pressing the soft key beneath ACTIVE results in the immediate printing of a STATUS REPORT listing the current system setup settings.

EXIT Pressing the soft key beneath EXIT returns the display to the HELP and STATUS INFORMATION display.

MT95000 QUICK START GUIDE TO OPERATION

INTRODUCTION: The MT95000 Recorder offers a wide range of recording capabilities with easy to use front panel control. The brilliant 2 x 40 line electrofluorescent display quickly guides you through the operation with little or no prior training

TO OPERATE THE RECORDER QUICKLY: Simply push the "Basic Recorder Run" key Depending upon the configuration ordered, the recorder will immediately run 8, 12, or 16 non-overlapping channels

Undedicated, or "soft keys" below the display are continually identified as the menu is changed with the interaction of the dedicated keys which are labeled. These dedicated keys include speed, zero and gain set-up, menu, recall etc.

TO EXIT: There will almost always be either an EXIT or a MORE key to take you out of the screen. Otherwise just press any MENU key to exit

SCROLLING: To move horizontally through different fields within the menu, press the softkey under the >>> symbol to scroll right or the <<< key to scroll left. The selected field will flash. To change the blinking field, press the INC (NEXT) softkey to increment through the available options and DEC(PREV) to decrement the field

CHART SPEED SELECTION: The chart speed can be set either by using the dedicated chart speed keys for either 1, 5, 25, 50, 100, or 200 mm per second, minute, or hour. To set chart speeds other than these press the SPEED key in the menu section and enter the desired speed in integer steps between 1 and 200 mm per second, minute or hour or 500 mm per second.

TO SET INSTA-SPEEDS: Press the SYSTEM key under MENU. Scroll through the main menus using MORE to locate INSTA SPDS. Press the softkey located under it. Any of the three INSTA-SPEEDS can now be set. The INSTA-SPEED will be saved and can be recalled by simply pressing either key A, B, or C under the INSTA-SPEED section on the front panel

TIME MARKS: The TIMER key in the MENU section offers a choice of time mark spacings

TRIGGER: To set up a Trigger Source the TRIGGER key under MENU is chosen. Trigger sources include: Off, manual, external, Host I/F, CH XX, manual or one channel, manual or Mult channels, manual or external, manual or host I/F. If a trigger source with an analog channel is chosen the exact form of the trigger can be programmed (slope, level)

GENERAL SYSTEM SET-UP: Under the SYSTEM key in the MENU section are many options relating to system operation.

They are:

Interchan - allows the choice of an event marker** or annotation in the interchannel buffer.

Grid Set - Turns major and minor grid divisions on or off.

Invert/Lift - Invert causes signal inversion. Lift simulates Pen-up/Pen-down.

Set Acq. - Set data acquisition options

Set Pback - Data Capture Playback options

Trig - Set Trigger Options, include: off, manual, host, CHXX, man or ext, man or host, man or CHXX

Time/Date - Edit time and date

Chan. ord. - Channel order can be rearranged to allow for overlap of any two channels without altering incoming wiring.

I/O-Communications set-up, RS232 or GPIB.

Default - Set Default parameters

Motor Src** - Choose motor clock source

Insta Spds - Set Insta Speeds A, B, C

Time Src** - Set IRIG A, B, H, NASA36 or internal

Sig Cond - Sets signal conditioner reporting on/off

Numerical - Set numerical range

RECORDER MODE CHANGE: To change modes press the MODE key in the MENU section. The available options are: 8-channel, 4-channel, 8 channel overlap, datalogger, dual speed, timer mode, formfeed, (12 channel, 12 channel overlap, 16 channel, 16 channel overlap, data capture and playback**). The entire selection can be seen by pressing the MORE softkey. To exit, either select a mode or hit any menu key.

EDITING INTERCHANNEL ANNOTATION BUFFER: Press EDIT key under MENU. Choose a channel to edit using the INC/DEC softkeys. Press the softkey under EDIT and type in desired text (up to 120 characters) using the alpha-numeric keypad. NOTE: For Interchannel annotation to appear on the chart, Annotation must be chosen for that channel. To select Annotation - Press SYSTEM under MENU. INTERCHAN will appear on the first menu. Press the softkey under INTERCHAN, select the channel using INC/DEC and select ANNOT.

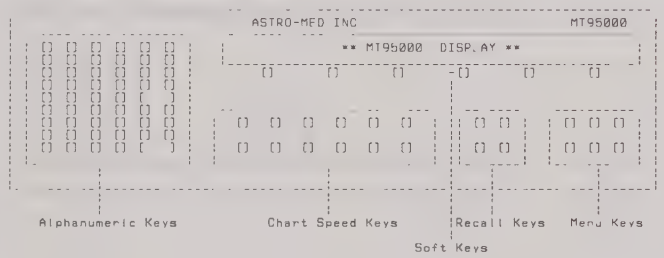
SAVING AND RECALLING PARAMETER SET-UPS: For your convenience the entire set of recording parameters can be saved with one keystroke for future "one touch" recording with frequently used recording parameters. To set a program into memory simply press the MEM key under RECALL and chose either MEM1, MEM2, or MEM3.

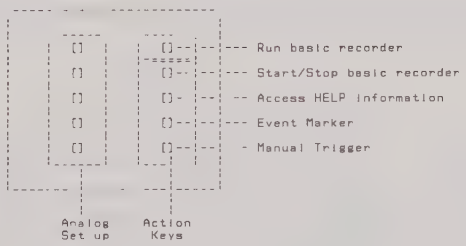
To recall a saved parameter set, press either 1, 2, or 3 in the RECALL section. To check the exact parameters saved in each memory, press the HELP key then select STATUS. Now the contents of either MEM1, MEM2, or MEM3 or the active set of parameters can be printed out.

**OPTIONAL - will not appear on menu unless option has been ordered.

Astro-Med, Inc.

MT95000 GENERAL KEYPAD INFORMATION





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MT-95000 MULTI-TASK RECORDER

Astro-Med, Inc.

** Alphanumeric Keys **

The alphanumeric keys located on the left side of the front panel allow easy text entry and editing. These keys include: A-Z, 0-9, ENTER, SPACE, FNC, INS, DEL, left arrow, right arrow, and several others.

** Soft Keys **

These 6 keys below the 80 character display change function depending on the menu. They are labelled by the bottom line of the display

** Speed Keys **

The 12 speed keys allow one-touch chart speed control. Six keys are dedicated to 1, 5, 25, 50, 100, and 200. Three keys [MM/SEC], [MM/MIN], [MM/HR] select the range. The A, B, and C keys are user programmable "Insta-Speeds"

** Memory Keys **

The MT95000 has the ability to store 3 different configurations and retrieve them easily

To bring up a system set up from storage a single keystroke performs the task. All parameter settings, whether the active set or the stored set, will remain unchanged even during the power cycle on/off.

Parameters are saved by pressing the [MEM] key followed by [1], [2] or [3].

To retrieve any set of parameter settings, an operator need only press [1], [2], or [3] key in the RECALL key section and that set of system settings will be re-instated

** Menu Keys **

The menu keys are a quick way to call up the most often-used menus:

[SYSTEM] - adjust recorder parameters
[TIMER] - set up timing marks
[SPEED] - change chart speed
[MODE] - change recording modes
[TRIGGER] - change trigger conditions
[EDIT] - edit text buffers

** Analog Set-Up **

These keys allow access to analog gain parameters:

[ZERO AND GAIN SET-UP] - brings up menu for changing baseline positioning and gain. Flexible coarse and fine adjustments are allowed.

[CALIBRATE] - causes the unit to automatically calibrate itself using an internal voltage reference

[MASTER GAIN] - allows quick method for user to set all other channels in the MT95000 to the same gain as channel 1

[EXTERNAL SIG. COND.] - to select MT95000 to accept the output of ASC900 series signal conditioners

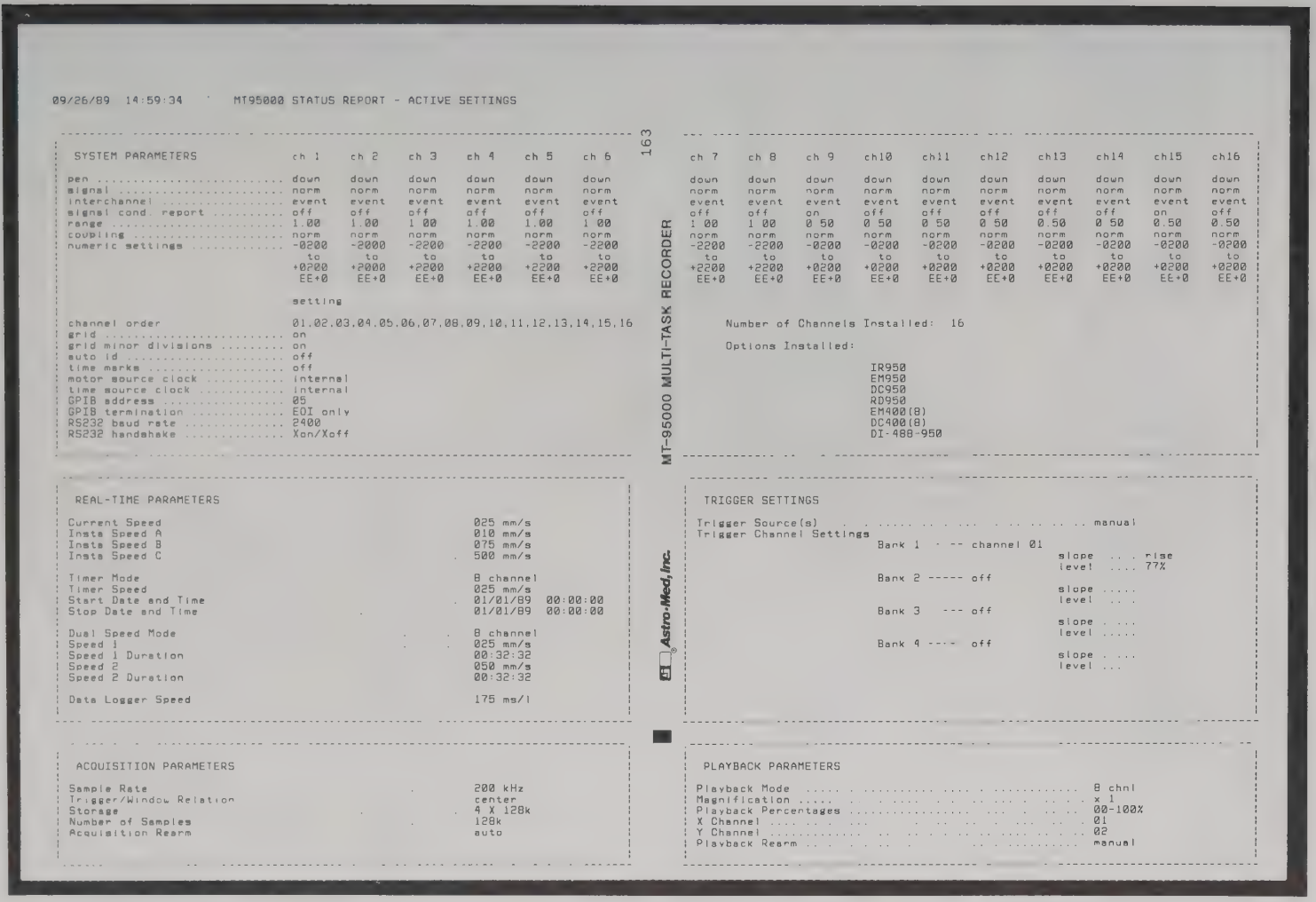
[CHANNEL ID] - prints a number on each analog signal for ease of identifying overlapped or re-ordered signals.

** Action Keys **

The remaining keys are:

[RUN] - this key initiates basic recorder operation
[START/STOP] - starts/stops chart
[HELP] - gets menu of help sheets
[EVENT] - manual control for system event marker #1
[MANUAL TRIG] - manual trigger

MT-95000 General Keypad Information Sheet



09/26/89 14:59:34 MT95000 STATUS REPORT - ACTIVE SETTINGS

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MT-95000 MULTI-TASK RECORDER

Astro-Med, Inc.

SYSTEM PARAMETERS

	ch 1	ch 2	ch 3	ch 4	ch 5	ch 6
pen	down	down	down	down	down	down
signal	norm	norm	norm	norm	norm	norm
interchannel	event	event	event	event	event	event
signal cond. report	off	off	off	off	off	off
range	1.00	1.00	1.00	1.00	1.00	1.00
coupling	norm	norm	norm	norm	norm	norm
numeric settings	-0200 to +0200 EE+0	-2000 to +2000 EE+0	-2200 to +2200 EE+0	-2200 to +2200 EE+0	-2200 to +2200 EE+0	-2200 to +2200 EE+0

	ch 7	ch 8	ch 9	ch10	ch11	ch12	ch13	ch14	ch15	ch16
	down	down	down	down	down	down	down	down	down	down
	norm	norm	norm	norm	norm	norm	norm	norm	norm	norm
	event	event	event	event	event	event	event	event	event	event
	off	off	on	off	off	off	off	off	on	off
	1.00	1.00	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
	norm	norm	norm	norm	norm	norm	norm	norm	norm	norm
	-2200 to +2200 EE+0	-2200 to +2200 EE+0	-0200 to +0200 EE+0	-0200 to +0200 EE+0	-0200 to +0200 EE+0	-0200 to +0200 EE+0	-0200 to +0200 EE+0	-0200 to +0200 EE+0	-0200 to +0200 EE+0	-0200 to +0200 EE+0

setting

channel order 01,02,03,04,05,06,07,08,09,10,11,12,13,14,15,16
grid on
grid minor divisions on
auto id off
time marks off
motor source clock internal
time source clock internal
GPIB address 05
GPIB termination EOI only
RS232 baud rate 2400
RS232 handshake Xon/Xoff

Number of Channels Installed: 16

Options Installed:

IR950
EM950
DC950
RD950
EM400(8)
DC400(8)
DI-488-950

REAL-TIME PARAMETERS

Current Speed	025 mm/s
Insta Speed A	010 mm/s
Insta Speed B	075 mm/s
Insta Speed C	500 mm/s
Timer Mode	B channel
Timer Speed	025 mm/s
Start Date and Time	01/01/89 00:00:00
Stop Date and Time	01/01/89 00:00:00
Dual Speed Mode	B channel
Speed 1	025 mm/s
Speed 1 Duration	00:32:32
Speed 2	050 mm/s
Speed 2 Duration	00:32:32
Data Logger Speed	175 ms/l

TRIGGER SETTINGS

Trigger Source(s) manual
Trigger Channel Settings

Bank 1	-- channel 01	slope rise
		level 77%
Bank 2	----- off	slope
		level
Bank 3	--- off	slope
		level
Bank 4	---- off	slope
		level

ACQUISITION PARAMETERS

Sample Rate	200 kHz
Trigger/Window Relation	center
Storage	4 X 128k
Number of Samples	128k
Acquisition Rearm	auto

PLAYBACK PARAMETERS

Playback Mode	B chnl
Magnification	x 1
Playback Percentages	00-100%
X Channel	01
Y Channel	02
Playback Rearm	manual

MT-95000 Status Report — Active Settings Sheet

EVENT Key

The recorder automatically prints an event marker along the left edge of the chart paper. Pressing the EVENT key causes the recorder's event marker to deflect to the left to mark data of interest to you. The event marker remains deflected while the EVENT key is pressed and is printed as a straight line when the key is released.

MANUAL TRIGGER Key

Pressing the MANUAL TRIGGER key causes an immediate trigger. When the key is pressed, the associated LED lights indicating that the key is active.

This LED has the broader function of illuminating when any trigger is sensed.

Section 4 Theory of Operation

4-1 System Organization

The operational system of the MT-95000/MT-96000 can be divided into three functional groups: system control, data acquisition, and print engine. Each of these groups is discussed in this section.

The MT-95000/MT-96000 uses five microprocessors to perform its functions. Each microprocessor has its individual memory, support circuitry, and set of tasks.

- System Processor
- Input / Output
- Utility Processor
- Master Controller
- Slave Controller

Understanding the roles and interactions of these microprocessors is essential to understanding how the MT-95000/MT-96000 operates.

System Processor

The system processor occupies the Central Processing Unit board. It provides system coordination and, during host control, interfaces with the host computer.

Input / Output (I / O) Processor

The I/O processor occupies the I/O board. The processor provides the front panel user interface and maintains therecorder's time reference.

Utility Processor

The Utility processor occupies the Utility board. The processor provides motor control and maintains the recorder's RAM card and light bars.

Master Controller

The Master Controller occupies the Master Controller Board. The controller directs Printhead 1, synchronizes the two printheads, and directs motor function.

Slave Controller

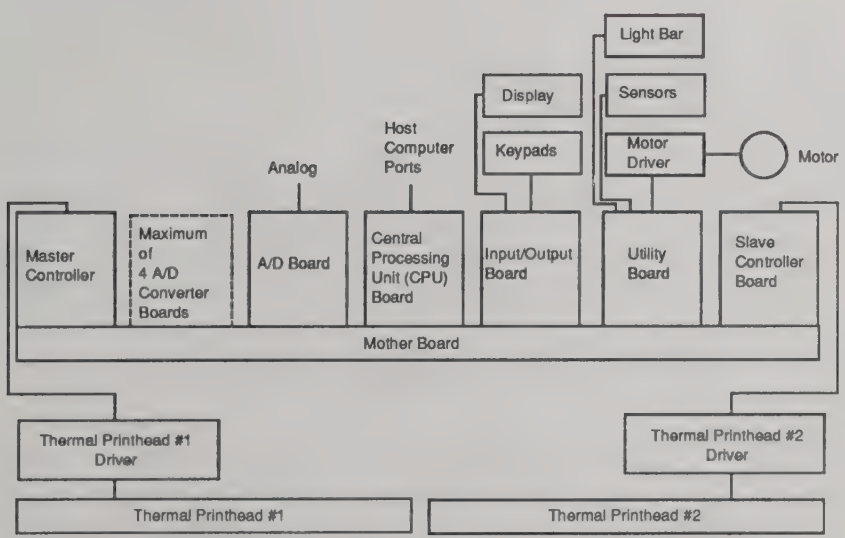
The Slave Controller occupies the Slave Controller Board. The controller directs Printhead 2.

4-2 System Control

System control is made up of those components involved in the overall control of the chart recorder. Central to system control is the system processor: a 16-bit microprocessor and its support circuitry. Located on the CPU board, the system processor coordinates the activities of all other processors.

The system processor communicates with other circuitry in the system through the system bus. The system bus is actually a set of digital signals that are made available to other boards in the system. Physical connection for the system bus is provided by the mother board. Each of the recorder's major electronic boards connects to the mother board. The motherboard also supplies power for digital logic (5 volts) and analog circuitry (+/- 15 volts). Major system components are represented below.

Major System Components



The front-panel, the GPIB (IEEE-488) port, and the RS-232 port each provide means for controlling the operations of the recorder. The front panel interface uses the I/O processor on the I/O board to interpret keypad entries and respond with appropriate displays. When the I/O processor receives a legitimate command, it transfers the command to the system processor. The system processor then directs the recorder to perform the requested task. The GPIB and RS-232 host-control ports are located on the CPU board and are handled directly by the system processor.

Tracking user entries is a principal function of the I/O processor. The I/O board uses a lithium battery and low-power random access memory to maintain all active system settings and up to 3 complete, alternate system setups.

A separate lithium battery supports a time keeping function by maintaining the I/O board's real-time clock and calendar. Time and date information are supplied to the rest of the system by the system processor.

The I/O board also contains circuitry for the demodulation and decoding of IRIG and NASA time codes.

4-3 Data Acquisition

As applied to the MT-95000/MT-96000, data acquisition is defined as the conditioning and conversion of analog waveforms to a digital format suitable for recording. This function is performed in the recorder's A/D boards which also contain the memory required for data capture. Control signals are transmitted over the system bus from circuitry on the CPU board.

The chart recorder accepts a maximum of four A/D boards providing the potential for up to 16 recording channels. Each A/D board supports four channels of analog waveforms and four interchannel event markers. The A/D boards also contain analog trigger detection circuitry. When the analog waveform data has been converted, it is passed by the system bus to the system processor.

4-4 Print Engine

The term "print engine" refers to those recorder components involved in printing and in moving the chart paper. The recorder has two thermal printheads mounted end to end. The left printhead is controlled by the master printhead controller. The right printhead is controlled by the slave printhead controller. Except for the end plate and some board switch settings, these boards are identical.

The term "master controller" derives from the fact that this controller generates a timing signal that synchronizes both printheads and controls the speed of the chart drive.

Both the master and slave printhead controller boards plug into the mother board. The system processor communicates with the boards through the system bus. Each controller converts waveform and text data received from the system processor into a processed data stream compatible with the thermal printheads.

4-5 Principles of Direct Thermal Recording

The technology of direct thermal recording requires thermally sensitive paper, a thermal printhead, and a method for controlling the energy supplied to the printhead.

A thermal printhead consists of a series of closely spaced resistive elements mounted on a nonconductive material. This assembly is coated with a protective glaze and mounted on a heat sink. A soft-rubber drive roller or platen holds the thermal paper uniformly against the printhead.

Voltage applied to the printhead's resistive elements causes current to flow and generate heat. The heat is conducted through the protective glaze to the thermal paper. Heat is also conducted to the heat sink on which the printhead is mounted. Thermal paper darkens with the application of sufficient heat. Astro-Med thermal paper marks clearly when exposed to approximately 80° C. Some of the factors affecting the energy required to raise the paper surface to this temperature include paper speed, glaze thickness, paper temperature, and element temperature.

4-6 Strobe Control

Three factors determine the amount of energy applied to each element of the printhead: the voltage across the element, the amount of time the voltage is applied, and the resistance of the element. The MT-95000/MT-96000 uses a print voltage of approximately 24 volts. The resistance of the printhead is fixed at approximately 1000 ohms. The master and slave controllers regulate the energy flow to the printheads by altering the length of time voltage is applied.

The applied voltage is called the "strobe." The duration for which the voltage is applied is called the "on time" or "strobe length." Each time new data is printed, the printhead is actually strobed twice.

The initial strobe is called the "pre-strobe" to distinguish it from the second pulse. The energy supplied by the two successive strobes is approximately equal to a single pulse of their combined strobe lengths. Application or nonapplication of the pre-strobe is used to compensate for heat build-up within the printing elements. Repeated use of an individual printing element does not allow for a cooling period between strobe cycles. Consequently, successive strobes can raise peak temperatures within an element to damaging levels.

To prevent damage, each controller has special circuitry that monitors the energizing history of all of the individual printing elements. This circuitry prevents the pre-strobe from being applied to elements that have not cooled sufficiently from the previous strobe cycle.

Each printhead controller also monitors the temperature of the printheads themselves by means a thermistor mounted within each printhead. Paper speed and printhead temperature are then used to determine the width of the second pulse.

Software is also used as a mechanism for energy regulation. The recorder employs a waveform history algorithm to reduce the energy applied to the printheads when high-speed waveforms are recorded. This reduces the possibility that excessive printing in one channel will drain the power supply and affect recording in other channels.

The instantaneous current required for the printing of high-frequency waveforms can be very high. A high-capacity, low-resistance capacitor is mounted close to each printhead to supply this current. The capacitors are recharged between strobe cycles.

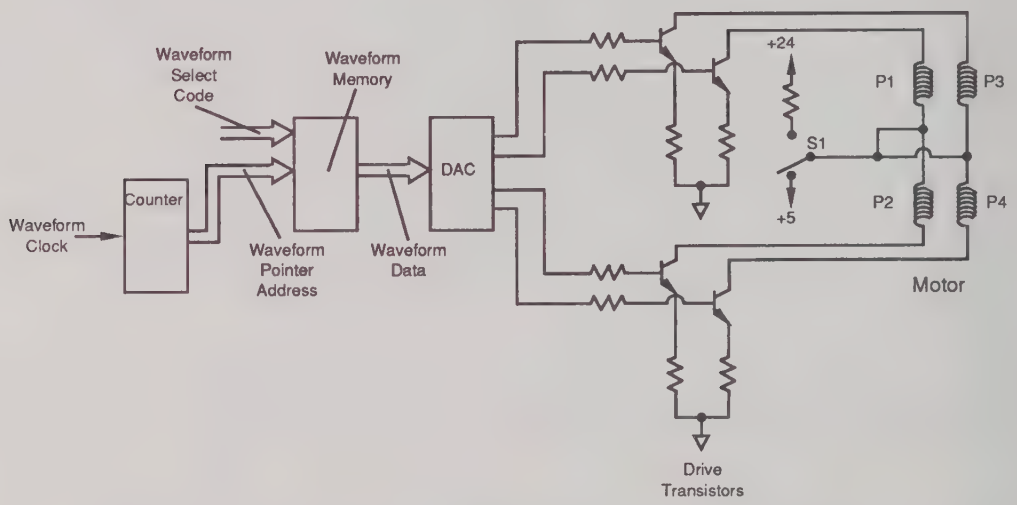
4-7 Chart Drive

The recorder's chart drive system is based on a stepper motor drive geared 16 half-steps per millimeter. The use of microstepping achieves a maximum chart control resolution of 256 steps per millimeter. The system processor provides commands to the master controller to initiate motor action. Through a dedicated parallel port, the master controller is linked to the Utility board which generates the pulses needed to support motor movement. It then transmits these pulses to the motor drive board mounted on an internal chassis wall. The motor drive board amplifies the signals and sends them to the motor.

4-8 Motor Control

The figure below illustrates the principal relationships between the major components of the recorder's motor control circuitry. The relay and drive transistors shown in the figure are located on the Motor Driver board. All other components are located on the Utility board.

Principal Components of Motor Control Circuitry



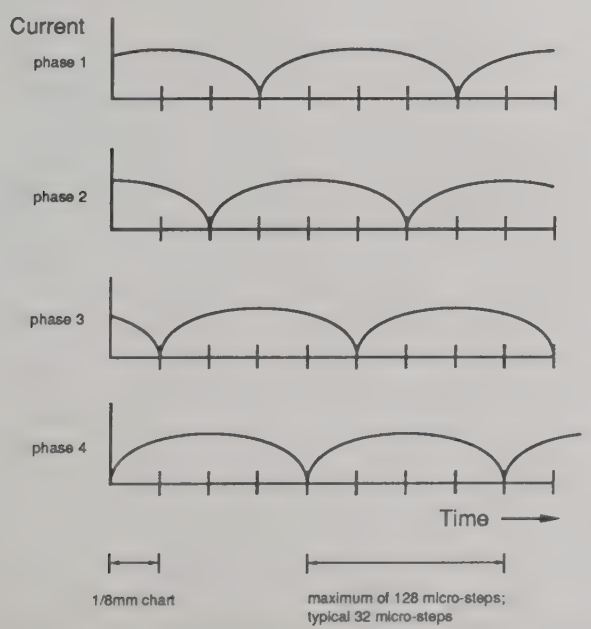
The MT-95000/MT-96000 uses a four-phase hybrid stepper motor with a step angle of 1.8 degrees. The motor and mechanical drive mechanisms advance the chart paper 1/16 of a millimeter with each half step of the motor. The relative currents flowing through each of the four major windings (phases) determine the actual amount of chart movement. The relative currents are determined by the drive voltage (either 24V or 5V) and the state of each drive transistor. The Utility board controls a relay (S1) that determines the drive voltage. Generally, the 24V drive voltage is used only at higher chart speeds. This helps to minimize both power usage and noise.

A digital to analog converter (DAC) generates the transistor base voltages that determine the flow of current through the motor windings. This permits precise control over the relative energizing of the four phases. Using this type of motor control, it is possible to move the motor in steps that are fractions of a full step. This is refered to as micro-stepping.

Current flow through each winding changes as a function of the motor waveform data supplied to the DAC. Motor waveform data is kept in waveform memory. A waveform clock determines the rate at which waveform data is supplied to the DAC. Each micro-step is associated with a burst of four pulses on the waveform clock. The pulses update each phase with new data which causes a small change in the winding energies resulting in chart paper movement.

A set of four simplified current curves is shown below. Each curve represents one of the four phases. The shape of actual curves varies with the operating mode and speed range. The waveform select code indicated in the figure is used to select the wave shape.

Motor Control Current Waveforms



4-9 Top of Form

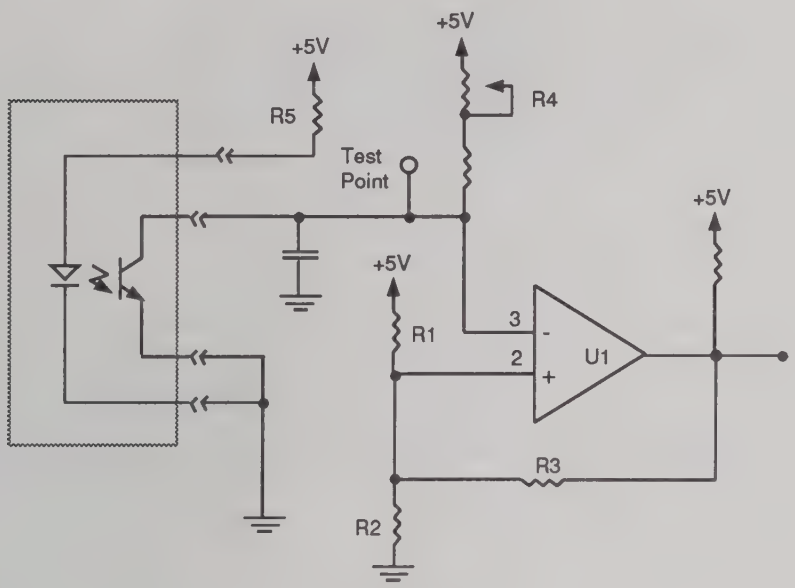
The recorder can use either roll or Z-fold thermal chart paper. When Z-fold paper is used, it may be desirable to start certain types of output at a point just below the Z-fold perforation: the "top of form" (TOF). Each sheet of Z-fold chart paper is marked with a black rectangle referred to as the index mark or TOF mark. Roll thermal paper has an index mark every 280 mm.

When the TOF moves under the TOF sensor, it is detected by circuitry on the printhead controller. The TOF sensor consists of an infrared emitting diode and a silicon phototransistor mounted in a plastic housing. The angles of both the diode and the phototransistor are fixed. They are arranged so that a reflective surface approximately 0.12 inches distant from the sensor assembly will cause the phototransistor to conduct. Because the TOF mark is nonreflective, the phototransistor does not conduct. During real-time recording, the TOF mark is ignored by the recorder.

Support circuitry for this assembly consists of

- a bias for the transistor
- a comparator with hysteresis
  to detect transistor conduction changes

The figure on the opposite page presents a typical circuit. The potentiometer is used to adjust the circuit for optimal performance. The comparator creates a logic level that is monitored by several processors. The circuitry is located on the Utility board.



4-10 Interlock

An infrared emitter/sensor assembly similar to the TOF monitor is mounted just above the paper tray. When the paper-chamber door is closed and the thermal paper is properly loaded, the infrared light is reflected by the paper. The reflected infrared activates a transistor sensor. The sensor voltage is converted to a logic level that indicates either "door open" or "no paper". The utility processor monitors the interlock level and causes an alarm to sound. The logic level is also used to gate the printhead strobe pulses. This ensures that the printhead will not be energized during an interlock condition.

4-11 Stall Sensor

Chart speeds of 100 mm/sec and greater cannot be obtained instantly because the torque required to overcome the inertia of the chart drive and paper might cause the motor to stall. Consequently, when high-speed commands are received, the Utility processor increases the chart speed gradually. This process is referred to as ramping the motor. Although observable at the 500 mm/sec chart speed, the ramp period generally is too short to be noticeable.

The stall sensor is required for those cases in which the motor is unexpectedly stopped. At most speeds when the motor is released after such an event, there is sufficient torque for it to continue running. However, to achieve very high speed the motor must be ramped. When the stall sensor detects that the motor has unexpectedly stopped, it advises the Utility processor to initiate a ramp.

The stall sensor includes a chopper wheel mounted to the motor shaft in such a way as to turn proportionally to the chart speed. An infrared diode and photo-sensitive transistor contained in a single plastic housing are mounted so as to shine a beam through the holes in the chopper wheel. Supporting circuitry on the Utility board is identical to that of the TOF and Interlock sensors. This circuit produces a pulse train with a frequency corresponding to the frequency with which the holes in the chopper wheel permit the infrared beam to reach the sensor. A timer on the Utility processor monitors the pulse train to determine if the motor is operating properly or has stalled.

4-12 Time Base Resolution

When recording real-time waveforms, resolution in the time axis is determined by a combination of chart speed and the frequency with which new information is supplied to the printhead. This frequency is called the writing rate or print rate. The MT-95000/ MT-96000 has a maximum print rate of 1600 Hz.

Typically, resolution in the time axis is specified in terms of the number of times waveforms are updated per each millimeter of chart paper. At chart speeds of 25 mm/sec or under, the recorder adjusts the writing rate to provide a resolution of 32 updates per millimeter. A writing rate of 800 Hz is required to achieve this resolution at 25 mm/s (32 x 25 = 800). The time base resolution for speeds in the range of 26 mm/sec through 100 mm/sec is fixed at 16 updates per millimeter. The time base resolution for speeds in the range of 101 mm/sec through 200 mm/sec is fixed at 8 updates per millimeter.

4-13 Annotation

The recorder provides four types of chart annotation:

- line printing
- rotated line printing
- channel annotation
- waveform ID

The system uses line printing to generate HELP and STATUS information. Rotated line printing is used to annotate calibration. Line printing and rotated line printing capabilities can be accessed through a host computer.

The recorder's channel annotation capability can be accessed either through the front panel or through a host computer. A text buffer containing space for 120 characters is provided with each waveform channel. An additional 30-character buffer printed at the end of the system log is also available. If the recorder's "talking" signal conditioner feature is enabled in any channel and signal conditioner settings are being recorded, available text buffer space in that channel is reduced to 80 characters.

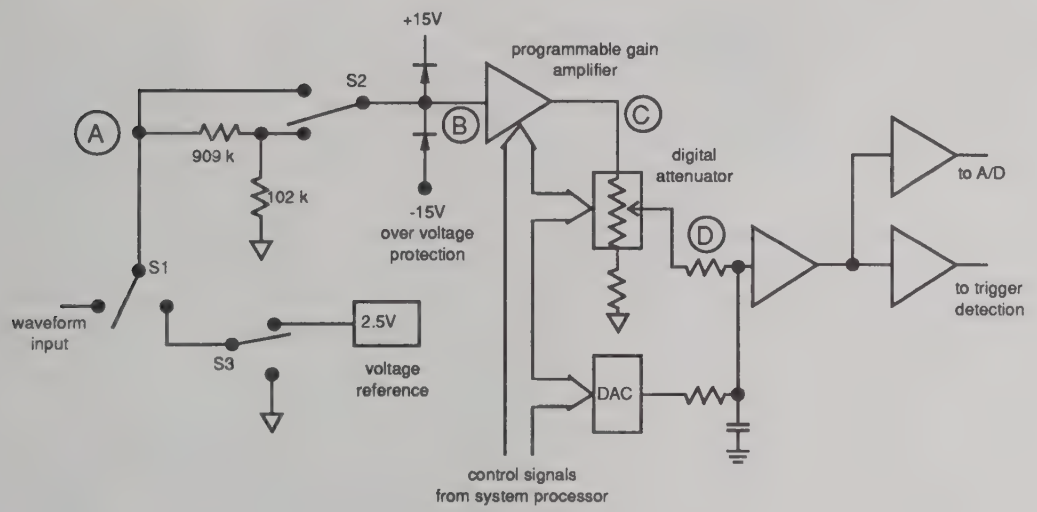
4-14 Internal Signal Conditioning

Each input channel of the MT-95000/MT-96000 has an internal, programmable medium gain amplifier or signal conditioners. This circuitry is located on the A/D boards. Each A/D board supports 4 channels of analog inputs. The recorder can accept 2, 3, or 4 A/D boards. This allows the recorder to be configured as either an 8-, 12-, or 16-channel system.

A simplified diagram of a single analog input channel is presented on the opposite page. Switches S1 and S3 determine whether point A is connected to the waveform input, a voltage reference, or common (zero volts). Depending on the state of switch S2, the voltage at point A is either directly connected to point B or is attenuated by a factor of ten. The system processor determines the positions of each of the three switches.

The programmable gain amplifier (PGA) can be set to any of four gain factors. In combination, the PGA and the initial switched attentuator stage provide eight discrete gain stages. These are the coarse gain stages made available to the user. Fine gain adjustment is provided by a programmable attenuator stage that follows the gain stage. The digital attenuator stage permits point D to be adjusted from 100% to 40% of point C in 100 steps. This circuitry is controlled by the system processor communicating with the A/D board via the system bus.

Recorder Analog Input Stage



To prevent aliasing of very high frequencies, the analog input circuitry also contains a low pass filter stage which is not shown above.

Baseline offset adjustment is provided by a digital to analog converter (DAC) under the control of the system processor. The DAC is 12-bit and allows more than 4000 adjustment steps. In all modes, this provides offset control to the dot level (1/12 mm). The offset voltage is bipolar and is added to the conditioned signal which is also bipolar.

The offset and conditioned waveform then goes to the trigger sense circuitry. A final stage uses level shifting to change the waveform from a bipolar signal to a unipolar signal. The final stage is required because of the 0 to 5V input range of the A/D converters.

4-15 External Signal Conditioning

In addition to the recorder's internal signal conditioners, the recorder can be used with Astro-Med's ASC-900 Series signal conditioners in an external C950 card cage. The full scale output of these external signal conditioners is 0.5V. When the recorder's internal signal conditioners are set to 0.5V full scale and the standard 50-division grid is used, external signal conditioner calibration is maintained. The recorder's EXT SIGNAL CONDITIONERS key provides a convenient means to ensure that calibration is maintained when external signal conditioners are used. This key automatically sets the gain of each channel to 0.5V full scale.

If signal conditioner reporting is enabled, the EXT SIGNAL CONDITIONERS key also causes the chart recorder to print the status of the external signal conditioners (rather than the internal) in the interchannel text buffers. The system processor obtains external signal conditioner status over the signal conditioner bus. This bus makes use of a 37-pin D-Shell connector located on the rear of the CPU board.

4-16 Calibration

Either upon power-up or upon user request, the recorder's programmable attenuator stage and an internal voltage reference source are used by the system processor to perform an automatic gain calibration. The calibration process tests and corrects baseline offset on every range and channel. The components used to implement this process are shown in the "Recorder Analog Input Stage" figure on the preceding page.

For each input channel, the system processor maintains a record of the most current offset corrections and most current gain correction factors. Each time power is applied to the recorder or the CALIBRATE key is pressed, these data are recalculated. In order to return the system to the same state, the recorder saves the value of the current range before it begins a calibration cycle.

The calibration cycle begins when switches S1 and S3 are set so that 0 volts (signal common) are applied to point A. The DAC is also set to 0 volts by the system processor. In the ideal case, the system processor would then read a value of 2048 from the A/D converter. This would indicate that the input voltage was at the exact center point of the range which corresponds to the center point of the chart. Because of the various voltage offsets that can accumulate in any analog circuitry, the processor will generally read something other than the ideal value.

The difference between the actual A/D reading and the true center of range is saved as the offset correction for the particular channel and range. Because analog offset error may vary with range, this calibration cycle is performed on each of the eight ranges. In each case, the offset error is saved. From this point, offset is corrected by using the DAC to compensate so as to ensure that the center of each A/D range always corresponds to 0 volts at the input.

By using an input attenuator (S2) and setting the PGA to the appropriate gain, the system processor then sets the range to 10V full scale. When this has been done and the correct offset has been supplied by the DAC, the 2.5V internal reference voltage is applied at point A. If the gain has been correctly set, the reference voltage produces an A/D reading that is 75% of full scale. The system processor adjusts the digital attenuator until the A/D reading is correct. The required attenuator setting is then memorized.

Each channel is independently corrected but there is only one gain correction factor per channel. It is assumed that changing the range has no significant effect on this correction factor.

Because the input is shorted directly to common and each range and channel are checked separately, offset error correction is extremely accurate. The accuracy of gain calibration depends on three factors:

- the accuracy of the voltage source
- the precision of the digital attenuator
- the variation in gain accuracy from range to range.

The recorder's internal voltage source is a precision reference that functions on the "bandgap" principle which produces a very stable reference. At room temperature, output voltage is accurate to within 0.1% with a maximum deviation of 10 ppm/°C.

The digital attenuator has 100 steps. The attenuator is in series with a resistor resulting in a gain change of approximately 0.6% per attenuator step. This forms the upper limit on the system's ability to correct for gain variations.

The input attenuator used in half the ranges is the major source of variation between ranges. This attenuator is made up of two components each of which is specified to a 0.1% tolerance. This results in a worst case variation of under 0.1%.

4-17 Real-Time Analog Recording: Data Acquisition

The paragraphs that follow discuss waveform sampling, the min/max recording approach, and frequency response.

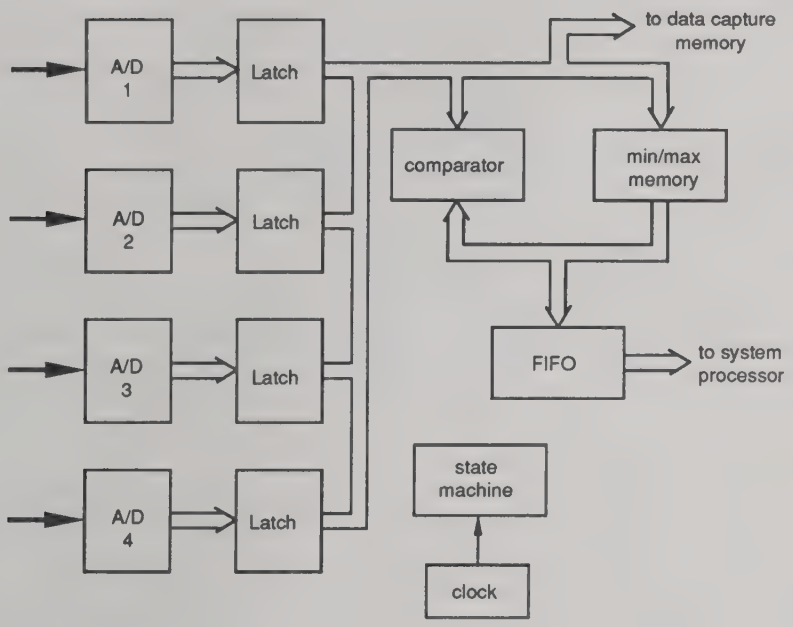
Waveform Sampling

The MT-95000/MT-96000 records analog waveforms by (1) sampling the waveforms at high speed, (2) converting the samples into line segments, and (3) printing these segments on the chart. The circuitry that controls waveform sampling can be described as a "state machine." This refers to the fact that the circuit is driven from one state of operation to the next at a fixed clock rate.

The basic elements of the data acquisition subsystem are shown in the figure on the opposite page. Most of the elements pictured are located on the individual A/D boards. Each A/D board supports four analog channels.

A micro-sequencer located on the CPU board is a crucial component of the state machine. The micro-sequencer sends state control information to the A/D boards through the system bus.

Data Acquisition Subsystem



The data acquisition cycle is based on a 12 MHz clock. Each state lasts 0.0833 micro-seconds. Each of the four channels on the individual A/D boards requires 15 states to complete the data acquisition process. As a result, the four channels of the A/D board can be acquired in 5 micro-seconds. This provides a sample rate of 200 kHz per channel.

Each channel has a 12-bit successive approximation A/D converter. The converter is associated with an independent data latch permitting simultaneous acquisition of all channels. While the state machine processes the data, a new conversion cycle can be started.

Min / Max

The min/max process emulates an ideal pen recorder or oscillograph with a very high frequency response. When recording high frequencies at low chart speeds, this ideal device draws lines between the maximum and minimum input values. A pulse train appears as a sequence of lines. A sine wave appears as a solid band. Signal amplitude is reproduced correctly regardless of paper speed.

In a similiar manner, the chart recorder reproduces a waveform as a series of lines. At most paper speeds, the lines are printed very close together. The resulting waveform has the appearance of a waveform produced by a traditional pen recorder having a very high frequency response. At very high speeds, limits on the printing rate may give the waveform a slightly digitized appearance.

The min/max process is implemented by the state machine ("Data Acquisition Subsystem" on the preceding page). When a channel has been sampled, the result is compared to the previous maximum value for that channel. If the newly sampled data point is larger than the previous maximum value, the new data point becomes the new maximum value. Similarly, minimum values are compared and replaced with smaller values as they are sampled. Data points that do not exceed maximum or minimum values are discarded.

Min/max data points are computed over a relatively short time period. Old maximum and minimum values are reset to the current value of the waveform at the beginning of the time period. Therefore, the min/max pair defines changes in the waveform over only a brief time period. Frequently, the maximum value will equal the minimum value. This indicates that the waveform did not change significantly during the period of interest.

As each line is drawn, the MT-95000/MT-96000 system processor concurrently:

- collects the current min/max pair, and
- resets the min/max pair to the current waveform value.

Consequently, each line represents only the change in the waveform that occurred from the time that the last line was drawn. For slow changing waveforms, only a point is drawn for many of the cycles because the maximum and minimum values are usually equal. High frequency events are sensed and recorded even at very low chart speeds. Frequency response is dependent on only the basic sample rate of 200 kHz per channel. Frequency response is not dependent on the writing rate which varies with speed.

Frequency Response

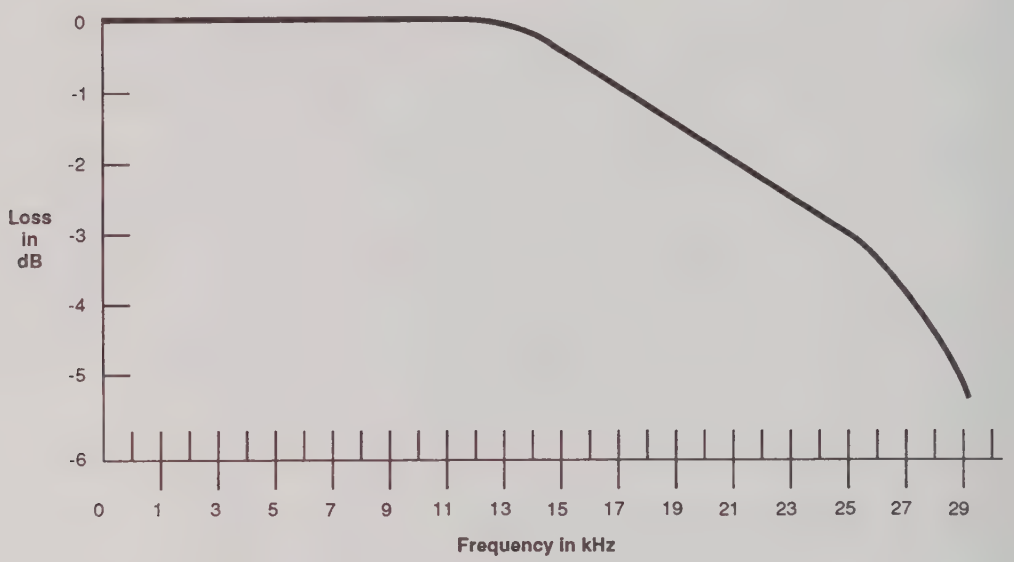
To a substantial degree, the frequency response of the MT-95000/MT-96000 reflects the characteristics of the previously discussed anti-alias filter. Traditionally, frequency response is presented as a plot of gain vs. frequency. A plot for a typical chart recorder analog channel is given on the following page.

Gain is represented in dB where:

$$dB = 20 \log [A / A_{ref}]$$

A = signal amplitude as read off the chart
A_{ref} = actual amplitude of applied signal

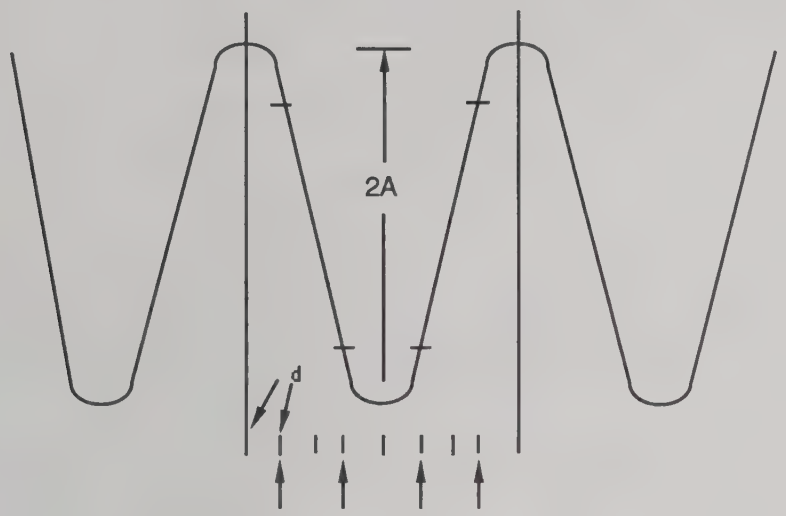
Typical MT-95000 Frequency Response



In the MT-95000/MT-96000, frequency response does not vary significantly with changes in gain. And, unlike the case of electro-mechanical recorders, frequency response in the MT-95000/MT-96000 is not dependent on the amplitude of the incoming signal.

The sample rate of each channel provides the ultimate limit on frequency response. Generally, a sample rate of ten times the frequency is considered adequate to reproduce a signal.

When discussing digital devices, one method for calculating frequency response is to consider the case of a sinusoid being sampled at regular intervals. As shown on the following page, the worst case occurs when samples are adjusted to be as distant from the peaks as possible.



In measuring the peak of the sinusoid, error is dependent on the number of samples that occur during a single cycle. Distance between the sample points is expressed in degrees as 360/n, where n is the number of points per cycle. If n is an even number, the worst case distance (d) between the nearest sample point and the waveform peak is given by:

$$d = [360/2n]$$

The value obtained when considering the nearest sample to the peak is given by:

$$x = A*\cos(d)$$

where A = sinusoid amplitude

Error can be calculated as a percentage of the peak:

$$PE = [1-\cos(d)] * 100$$

Error can also be calculated in dB:

$$dB = 20*\log[x/A] = 20*\log[\cos(d)]$$

For n = 8, the result is:

d = 22.5 deg, x = 0.924, PE = 7.6%, dB = -0.68

For n = 6, the result is:

d = 30.0 deg, x = 0.866, PE = 13.4, dB = -1.2

For the MT-95000:

n = 8 occurs at 25 kHz
n = 6 occurs at 33 kHz

4-18 Amplitude Resolution

The level of detail that can be seen or "resolved" on the chart is referred to as resolution. Resolution should not be confused with frequency response. Frequency response describes the ability of the chart recorder to respond to a changing input. When discussing older-technology pen recorders, resolution is usually described in terms of trace thickness and the speed of the chart. In practice, resolution is also influenced by the system's linearity.

Chart speed, linearity, and a factor similar to trace width also influence the resolution of new-technology chart recorders. Time base resolution and the effect of chart speed are discussed in section 4-2. The trace-width factor depends on the size of the print elements and the distance between print elements. In comparison to the older-technology recorders, the nonlinearity of the MT-95000/MT-96000 is insignificant. As a result, the recorder's resolution of the can be specified in dots per millimeter (dots/mm). The resolution of the thermal printhead is fixed at 300 dots/inch (11.81 dots/mm).

The recorder uses four standard channel sizes for waveform recording. Channel sizes are designed to maximize the useable range of the recorder's A/D boards and optimize the signal to noise ratio. Rounded to the nearest millimeter, the four standard channel sizes are:

- 21 mm (250 dots)
- 42 mm (500 dots)
- 85 mm (1000 dots)
- 169 mm (2000 dots)

Channel size refers to the area covered by the grid. In actuality, the signal's full range exceeds the grid by a distance that varies with the size of the grid. As received from the A/D's, the data consists of 12 bits allowing for 4096 possible steps over the range.

NOTE

The number of steps available from a sample with N bits is: 2^N-1.

The most accurate representation of the waveform requires a direct correspondence between each step available from the sample and the dots available on the chart. Any other step/dot relationship requires interpolation resulting in some level of waveform distortion. During real-time recording, the chart recorder does not use interpolation. The 12-bit sample provides more data than required for any of the standard grids. To match sample data to chart requirements, the system processor drops one or more least significant bits.

For example, when 42 mm channels are used, the system processor drops the least significant 3 bits leaving a 9-bit sample. This provides 512 steps over the range of the A/D and leaves 12 steps (0.5 mm) on each side of the channel size. When the 169 mm grid is used, 11 bits are required. This provides 2048 steps of which 48 are over-range (2 mm on each grid side). In all cases, resolution is approximately 12 dots/mm.

Another perspective is to consider amplitude resolution as a percentage of full scale. When the 42 mm (500 dots) grid is used, resolution is 0.2% of full scale (1/500). If the largest grid size is used, resolution can be increased to .05% of full scale (1/2000).

4-19 Data Capture

The Data Capture option (DC-950) provides the recorder with the ability to increase the time resolution of the recorded waveform. This is achieved by storing sampled waveform data in memory rather than recording the data in real time. Consequently, paper speed no longer acts as the upper limit on waveform resolution. When stored, the waveform information either can be replayed in a variety of formats or transferred to a host computer for analysis.

The A/D board contains most of the circuitry that supports data capture and trigger detection. Each A/D board supports the capture of a maximum of four channels of analog waveforms and their associated event marker inputs. The MT-95000/MT-96000 can capture data without interrupting ongoing real-time recording.

Sample Rate

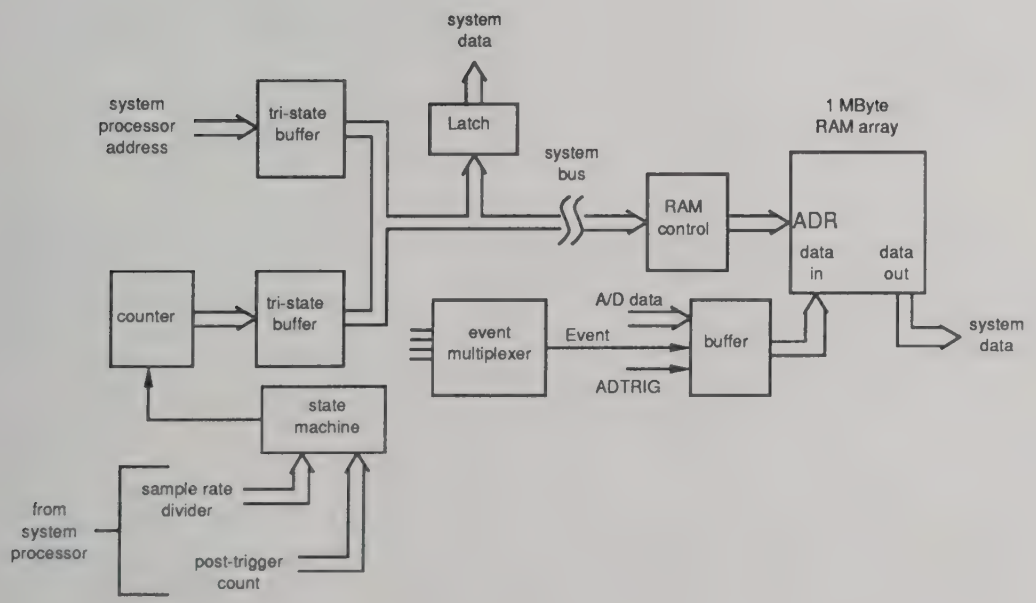
The data acquisition state machine fixes the sample rate at 200 kHz per channel. Lower samples rates can be selected down to a minimum of 1 kHz. The term "sample window" refers to the time period during which data is captured. The sample window is a product of the number of samples acquired and the time period between each sample. When a lower sample rate is chosen, the time period between samples increases and, consequently, the sample window is increased.

When a sample rate less than the maximum is chosen, frequency response is reduced because the recorder's data capture circuitry saves single points rather that min/max pairs. In general, it is preferable to sample data 6 to 10 times faster than the highest frequency to be observed.

Data Capture Memory

Each A/D board contains 1 million bytes (1 MByte) of dedicated data-capture memory. Data capture memory can only be written to by the data acquisition electronics and can only be read by the system processor via the system bus. The components of data capture memory are shown below.

Data Capture Memory



During data capture, a channel code determines which of the four channels is saved. The data acquisition state machine generates the channel code and sequentially selects the four channels. Latched waveform data from the selected channel (see "Data Capture Memory") is combined with:

- the state of the selected channel's associated event marker
- the state of the trigger pulse.

A 16 bit word is saved for each sample providing a capacity of 512 thousand samples per board. As each sample is saved, a counter increments the memory location.

Data capture memory is configured as a circular buffer. Data can be acquired even when the buffer is full because the oldest data in the buffer is constantly replaced by the newest data entering the buffer.

By specifying certain parameters of the data acquisition state machine, the system processor regulates several aspects of data capture. Until a trigger is detected, data can be acquired indefinitely. The post-trigger count determines the number of sample points collected after a trigger occurs. This determines the relationship between the sample window and the trigger event.

As an alternative to dividing acquisition between four channels, the system processor can cause the state machine to allocate all 512 thousand sample locations to a single channel.

To calculate min/max values, the state machine always samples waveforms at 200 kHz. However, not every sample needs to be stored. The system processor uses a sample rate divider to instruct the state machine to ignore some number of samples. For example, a sample rate divider of 4 causes only every fourth sample to be saved. This results in an effective data capture sample rate of 50 kHz. 200 is the maximum useful divider and establishes the lower limit 1 kHz for a data capture rate.

During playback, the system processor controls the memory address via the system bus and associated buffers. The system processor can access any portion of data capture memory.

Triggering

"Triggering" is the mechanism that enables the chart recorder either to begin operation or alter operation in response to various stimuli. Any of the following may constitute a trigger:

- a specific change in any analog input
- a switch closure or low logic level on the external trigger
- a pulse on the GPIB trigger line
- pressing the front-panel MANUAL TRIGGER key
- a command from the system processor

The major components involved in the triggering process are illustrated in the trigger block diagram on the following page. The result of the triggering process is a pulse on the SYSTRIG line. The triggering pulse can:

- initiate a data capture
- interrupt one of the processors and prompt it to perform an action, e.g., change recording speed

A multiplexor located on the I/O board and controlled by the I/O processor determines the SYSTRIG source. The trigger can be (1) set to disabled, (2) set to respond only to manual initiation, or (3) set to respond to manual initiation in combination with other multiplexor inputs.

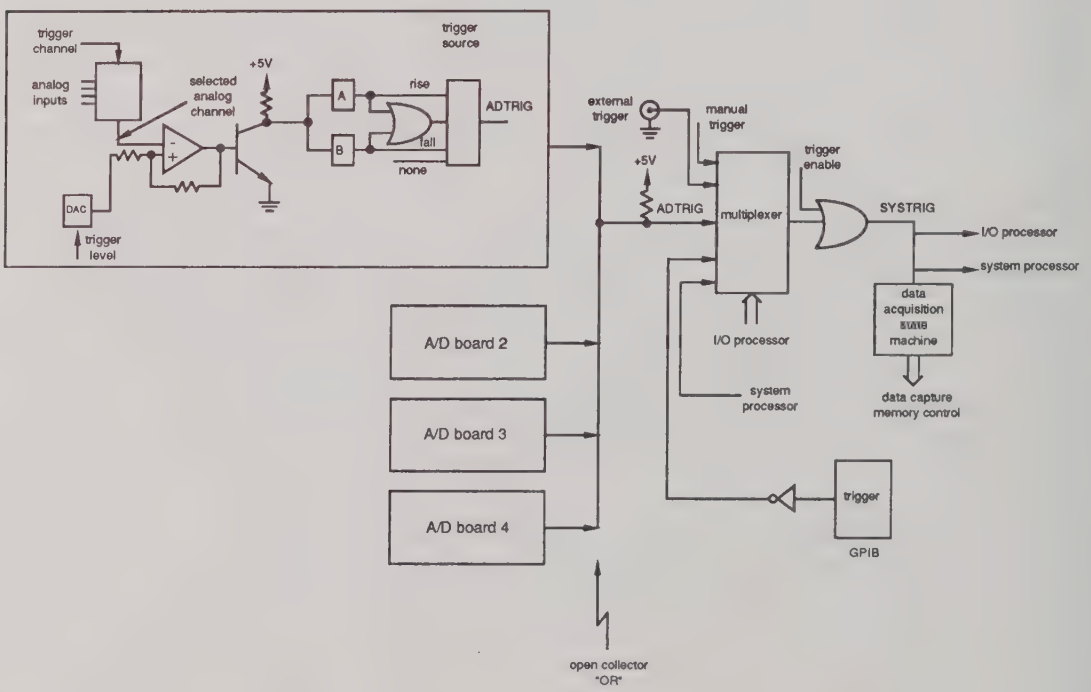
The ADTRIG line is one of the other multiplexer inputs. The ADTRIG line is an open collector logic level connected by the system bus to all installed A/D boards. "Open collector" indicates that the line can be activated by any or all boards creating an OR function. As seen in "Trigger Block Diagram," each A/D board has a multiplexor that is used to select one of the board's four channels as it's potential source of ADTRIG.

Finally, each A/D board contains a second multiplexor and a DAC that, in combination, determine the specific waveform conditions required to generate a trigger. The waveform is compared to a programmable reference level provided by the DAC. The multiplexor can be programmed to:

- produce a trigger when the waveform rises above the programmed reference level.
- produce a trigger when the waveform falls below the programmed reference level.
- produce a trigger when the waveform either rises above or falls below the programmed reference level (both).

In addition, each A/D board can be set to refrain from producing triggers under any conditions (none).

Trigger Block Diagram



4-20 Time Annotation

The system log is automatically annotated by the recorder with the current time and date. The system log begins with the symbol "<." This indicates the point on the chart referred to by the subsequent information. Two sources can supply time and date information to the instrument: the recorder's real-time clock or an external time code. In either case, the recorded time is capable of 0.1 second accuracy if the time source supports it. It is important to note that, generally, the "<" symbol of the system log is not synchronized to any particular time. Rather, the symbol is spaced so that time and date information appear at least once every two Z-fold pages.

Real-Time Clock

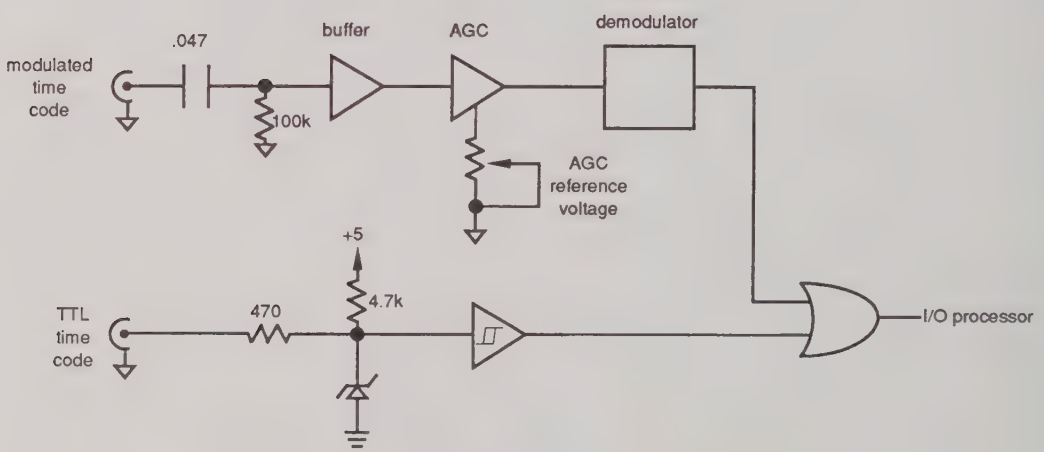
A low power real-time clock maintains the time and date. This device divides the frequency of an intrinsic crystal-referenced oscillator and produces a signal at one-second intervals. The signal updates the time and date and serves as the recorder's time reference. The I/O processor monitors the real-time clock and supplies time and date information to the system microprocessor. A lithium battery backs-up the real-time clock.

External Time Codes

The recorder can decode several standard serial time codes. It can then print this decoded information in the system log instead of the time reference supplied by the recorder's internal clock. The time codes developed by the Inter-Range Instrumentation Group (IRIG) are the most commonly employed. In IRIG code, time and date information are serially transferred as binary coded decimals (BCD's) using pulse width coding. Currently, the MT-95000/MT-96000 supports IRIG A, B, H, and NASA 36 time codes. The recorder's external time code input stage is shown below.

To produce a pulse train, external time codes are available in two forms: modulated on a carrier frequency or demodulated. If the signal is demodulated, the pulse train should be TTL compatible. This means that a zero must be between 0 and 0.8 volts and a one (1) must be between 2.5 and 5 volts.

Extenal Time Code Input Stage



The occurrence of the "<" symbol that precedes the system log can be synchronized to print within 10 milliseconds or no more than 1/16 mm at slow paper speeds of the start of the external time code. This increases the accuracy of the system log.

4-21 Numerical Recording

The chart recorder is able to record waveforms as a series of numerical values. This is accomplished by taking digitized data from the data acquisition electronics at a rate set by the user. This mode has a particularly useful feature. It rescales the sampled data and presents the converted data as user-defined engineering units.

The data acquisition subsystem provides the raw data as a min/max pair for the period of time since the last sample. This data has 12-bit resolution ranging from 0 to 4095. The calibration of the system is such that the center of this range (2048) corresponds to the center of the recording channel. When the waveform is adjusted to produce a flat line in the center of the grid, the min and max values supplied by the data acquisition subsystem both equal 2048.

This is significant in that a fixed relationship is established between the input voltage and the output of the A/D converter. The datalogger feature takes the value supplied by the A/D subsystem (number of steps) and scales it based on the calibration set by the operator. Scaling is based on the following equation:

$y = mx + b$ where: y = scaled result

m = slope

x = A/D value

b = offset

To specify m and b directly would require a detailed knowledge of the relationship between the A/D output and the input signal. To eliminate this requirement, the user is required to indicate the value of the input signal (in the units desired) at the left side (LS) of the grid and the value of the signal at the right side (RS) of the grid. The system then calculates m = (RS - LS) / grid width. Grid width is the number of A/D steps between the right and left sides of the grid. The value for b is found by computing the center of the chart (c) in user-defined units ([RS - LS] / 2). The value of b is given by:

$$b = 2048 - mc$$

It is important to note that the precision of the printout is limited by the resolution of the A/D converter. This cannot exceed four digits. As a consequence, calibration factors are specified as four significant digits and an exponent. Because all calculations are performed using integers, the exponent is used only to place a decimal point or to add trailing zeros.

4-22 Event Markers

The MT-95000/MT-96000 provides a number of event marker inputs. In general, these are specified as operable with a TTL level or switch closure.

The typical event marker input is a TTL gate with a 4700 ohm pull-up resistor. This ensures that the event is off when no signal is connected. The pull-up resistor is connected to the internal 5 volt logic supply. In order to activate the marker, the input must be forced to a TTL low. This requires that the input be less than 0.8 volts and preferably less than 0.5. This is easily done by using a wire or relay to short the input to common. This is the definition of "switch closure operable."

If the source is an electronic circuit, it must be able to sink approximately one milli-ampere (5 volts / 4700 ohms). Any TTL compatible device easily accomplishes this.

Appendix A

menus available from the front panel

MEM Key (programming a setup)

SAVE CURRENT SETTINGS
Select MEM 1, 2, or 3 | EXIT |

↓

Saving to MEM X

MEM Key (recalling a setup)

Recall will erase current settings
Continue recall? | YES | NO |

↓

Recalling setup from MEM X

SPEED Key

XXX mm/x Use keypad or speed keys.
Press [enter] to accept.

SYSTEM Key

Please consult the SYSTEM Key foldout for a view of the menus associated with the SYSTEM key.

MODE Key

Please consult the MODE Key foldout for a view of the menus associated with the MODE key.

EDIT Key

Enter channel to edit? Channel
| | | INC | DEC | EDIT |

↓

CHANNEL #01
ch 01 Pos 001 | more |

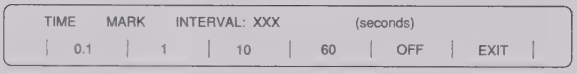
↓

ch 01 Pos 041 | more |

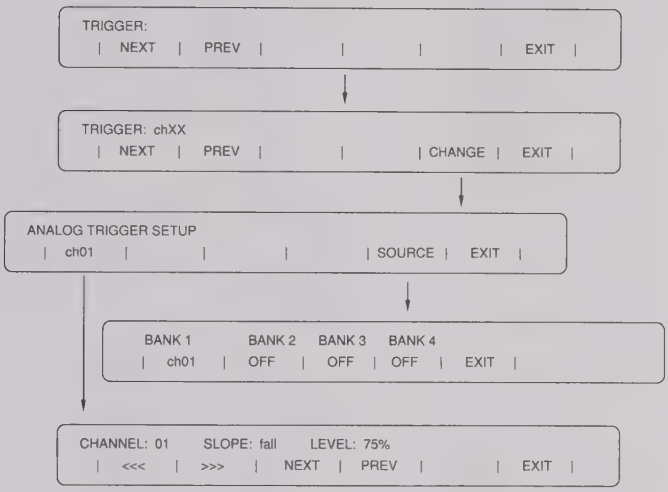
↓

ch 01 Pos 081 | more |

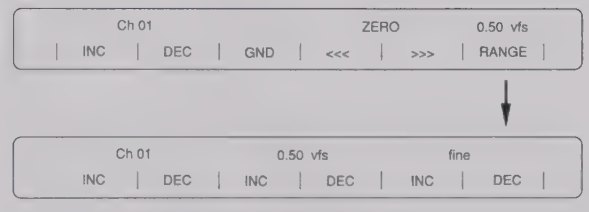
TIMER Key



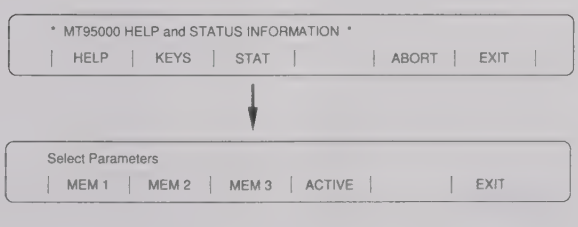
TRIGGER Key



ZERO AND GAIN SETUP Key



HELP Key



INTER CHAN

Channel XX w/annotation

| INC | DEC | NONE | ANNOT | EVENT | EXIT |

CHAN ORDER

CHANNEL ORDER: 01 02 03 04 05 06 07 08

| <<< | >>> | INC | DEC | more | EXIT |

more ORDER: 09 10 11 12 13 14 15 16

| <<< | >>> | INC | DEC | more | EXIT |

GRID SET

GRID. on MINOR DIVISIONS: on

| <<< | >>> | ON | OFF | | EXIT |

INVERT LIFT

Chan XX Pen: down Signal: norm

| <<< | >>> | UP | DOWN | NORM | INVERT |

SAMPLE RATE: 200 kHz TRACE: 99

| <<< | >>> | NEXT |

MEM DIV: 4 X 128 SAMPLES: 128

| <<< | >>> | NEXT |

ACQUISTION ARM: auto – rearm

| | | NEXT |

TIME DATE

06/25/89 13:10:46 Set Time and Date

| <<< | >>> | INC | DEC | | EXIT |

I/O

| COMM | UP | | | | |
| SET | GRADE | | | | EXIT |

See pages 3-82 through 3-89 of this manual for complete information regarding the I/O submenus.

DE FAULT

Select parameter to default

| ANNOT | ZERO | NUMER | CH. ORD | | EXIT |

MOTOR SRC

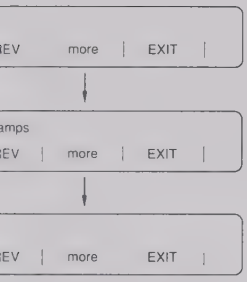
MOTOR CLOCK SOURCE: internal

| | | INTRN | EXTRN | | EXIT |

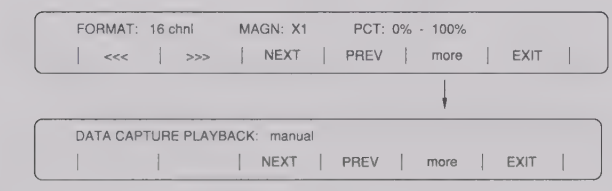
A=XXX mm/X B=XXX mm

| A | B |

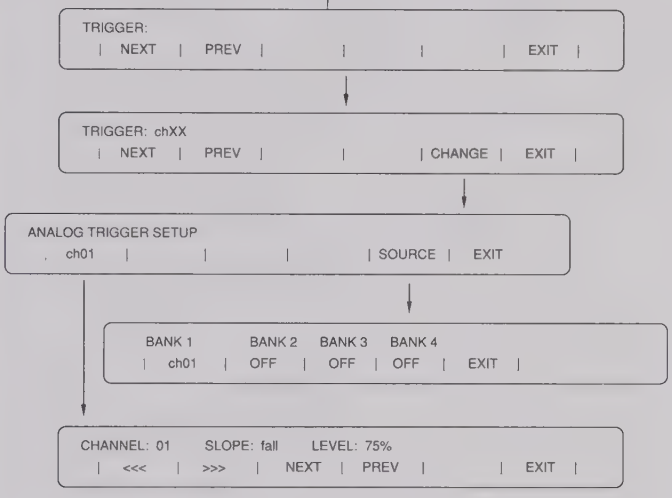
SET ACQ



SET PBACK



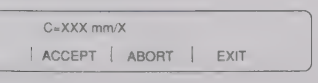
TRIG


TRIGGER:
| NEXT | PREV | | | | EXIT |
TRIGGER: chXX
| NEXT | PREV | | | CHANGE | EXIT |
ANALOG TRIGGER SETUP
ch01 | | | | SOURCE | EXIT
BANK 1 BANK 2 BANK 3 BANK 4
| ch01 | OFF | OFF | OFF | EXIT |
CHANNEL: 01 SLOPE: fall LEVEL: 75%
| <<< | >>> | NEXT | PREV | | EXIT |

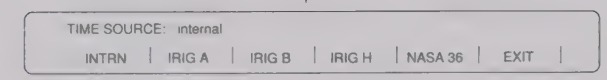
BC ARM and BC DISARM

No menus are generated by the use of either of these setups

INSTA SPDS

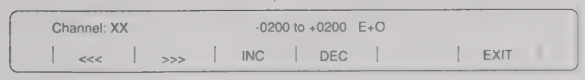


TIME SRC



SIG COND

NUMER ICAL



8 CH

4 CH

04/22/89 15:10:33
4 Channel REAL-TIME Spd 25 mm/s

06/29/89 16:09:13
8 Channel REAL-TIME Spd 5 mm/s

8 ch Olap

Data Log

03/01/89 07:08:44
Data Logger Spd 50 ms/l

11/03/89 22:19:55
8 ch Overlap REAL-TIME Spd 15 mm/s

12 Ch

01/09/89 11:3
12 Ch Overlap REAL

09/27/89 14:22:09
12 Channel REAL-TIME

Data Capture (manual playback option)

DATA CAPTURE: Manual Arm – Manual Playback
Press RUN to start Capture | RUN | EXIT |

↓

DATA CAPTURE: Manual Arm – Manual Playback
ACQUIRING DATA | EXIT |

↓

DATA CAPTURE: Manual Arm – Manual Playback
ACQUISITION COMPLETE | EXIT |

↓

DATA CAPTURE: Manual Arm – Manual Playback
Press RUN for Playback | RUN | EXIT |

↓

DATA CAPTURE: Manual Arm – Manual Playback
DATA PLAYBACK | PAUSE | EXIT |

↓

DATA CAPTURE: Manual Arm – Manual Playback
PLAYBACK PAUSED | RUN | EXIT |

↓

DATA CAPTURE: Manual Arm – Manual Playback
PLAYBACK COMPLETE | EXIT |

Data Capture (auto playback option)

DATA CAPTURE: Manual Arm – Auto Playback
ACQUIRING DATA | EXIT |

↓

DATA CAPTURE: Manual Arm – Auto Playback
ACQUISITION COMPLETE | EXIT |

↓

DATA CAPTURE: Manual Arm – Auto Playback
DATA PLAYBACK | PAUSE | EXIT |

↓

DATA CAPTURE: Manual Arm – Auto Playback
PLAYBACK PAUSED | RUN | EXIT |

↓

DATA CAPTURE: Manual Arm – Auto Playback
PLAYBACK COMPLETE | EXIT |

Play Back

DATA PLAYBACK
PCT: 00 – 100% MAGN: X1 |

PLAYBACK PAUSED
PCT: 00 – 100% MAGN: X1 |

PLAYBACK COMPLETE
PCT: 00 – 100% MAGN: X1 |

12 ch olap

IME Spd 25 mm/h

Spd 35 mm/h

16 Ch

08/19/89 07:21:37
16 Channel REAL-TIME Spd 75 mm/s

16 ch olap

10/21/89 07:21:37
16 Ch Overlap REAL-TIME Spd 125 mm/s

Form Feed

07/24/89 09:52:12 *READY*
press [RUN] for 8 channel or [HELP]

USE | EXIT |

UN | EXIT |

UN | EXIT |

Dual Spd

REALTIME DUAL SPEED OPERATION
| START | SETUP | | | | EXIT |

DUAL SPEED RECORDER FORMAT: 8 channel
| | | | NEXT | PREV | more | EXIT |

SPEED 1: 025 mm/s DURATION: 00:00:05
| <<< | >>> | NEXT | PREV | TRIG | EXIT |

SPEED 1: 025 mm/s DURATION: trigger
| <<< | >>> | NEXT | PREV | TIME | EXIT |

If DURATION set for a specific time, recorder operates at SPEED 1 until timing out and toggling to SPEED 2.

If DURATION set for trigger, recorder operates at SPEED 1 until a trigger is sensed and initiates toggling to SPEED 2.

SPEED 2: 050 mm/s DURATION: 00:00:10
| <<< | >>> | NEXT | PREV | TRIG | EXIT |

SPEED 2: 050 mm/s DURATION: trigger
| <<< | >>> | NEXT | PREV | TIME | EXIT |

If DURATION set for a specific time, recorder operates at SPEED 2 until timing out and toggling to SPEED 1

If DURATION set for trigger, recorder operates at SPEED 2 until a trigger is sensed and initiates toggling to SPEED 1

Timer Mode

TIMER SETUP start: 07/27/89 11:33:00
| <<< | >>> | NEXT | PREV | MODE | BEGIN |

Speed: 025 mms MODE: 8 channel
Use keypad for spd | NEXT | PREV | EXIT |

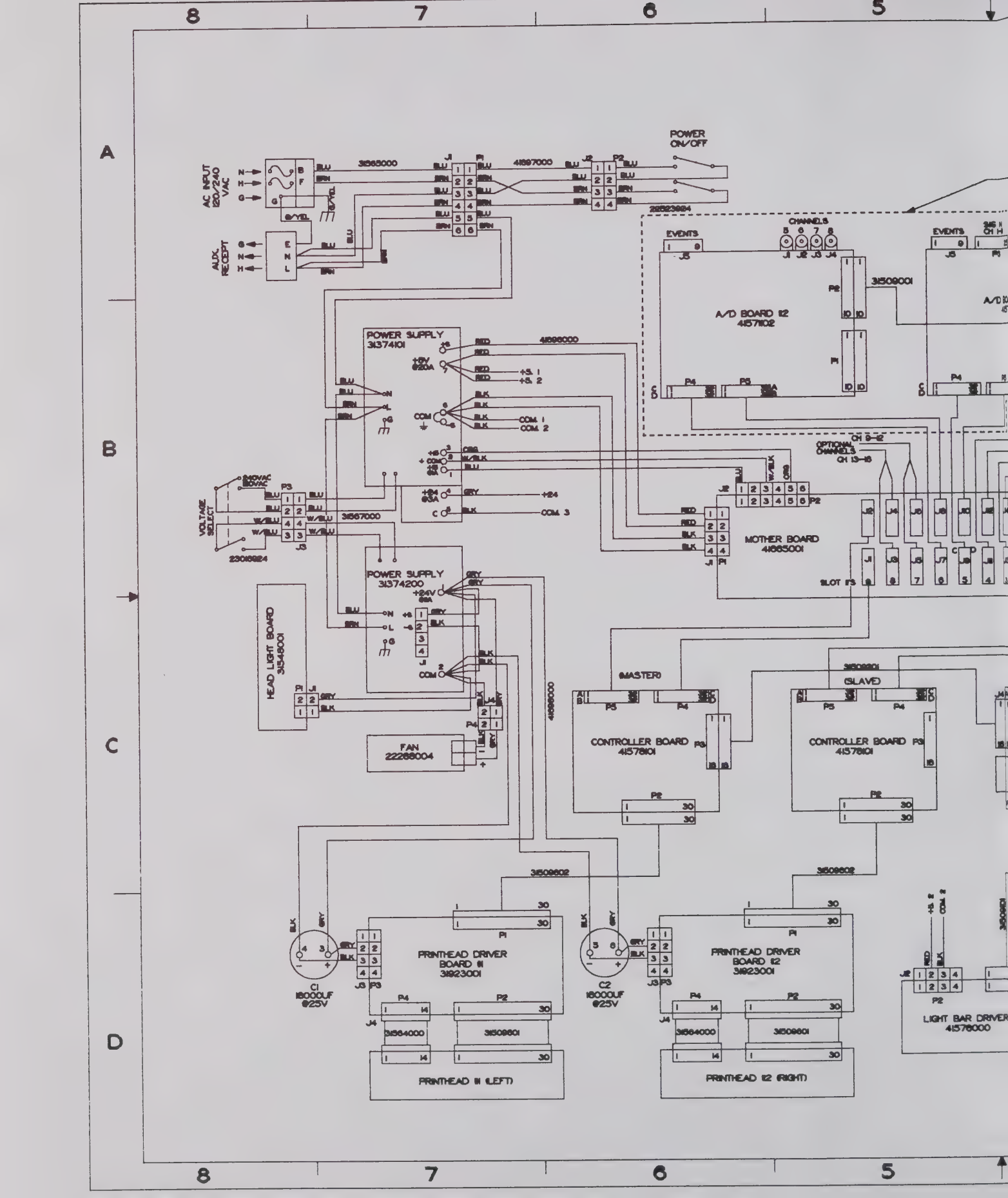
07/27/89 13:47:46 TIMER MODE
start 07/27/89 19:00:00 | SETUP | EXIT |

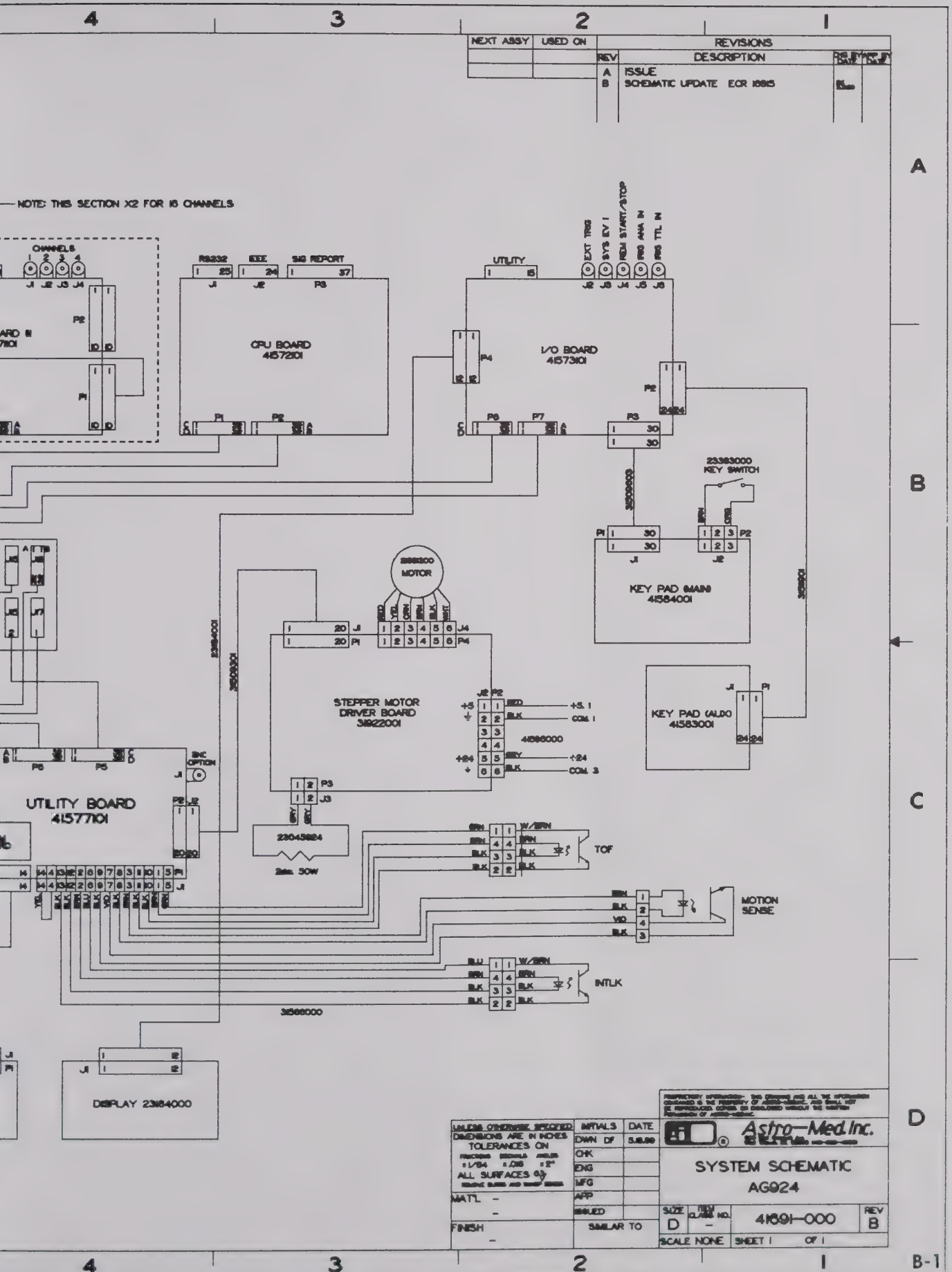
If Datalogger is the selected mode, TIMER menus will resemble those below.

TIMER SETUP start: 07/27/89 11:33:00
| <<< | >>> | NEXT | PREV | MODE | BEGIN |

MODE: data log
| spd | NEXT | PREV | EXIT |

177 ms/l Use keypad to edit speed, ENTER
to Accept. | ms/ | s/ | m/ | EXIT |


POWER ON/OFF
AC INPUT 120/240 VAC
AUX. RECEPT
3565000
41697000
22823004
A/D BOARD 12
4157102
3509001
CHANNELS
EVENTS
POWER SUPPLY
3137401
41696000
+5V 6/20A
+5.1
+5.2
COM
COM. 1
COM. 2
+24 6/3A
+24
COM. 3
VOLTAGE SELECT
240VAC
120VAC
3567000
23016024
MOTHER BOARD
4166001
OPTIONAL CHANNELS
CH 9-12
CH 13-16
SLOT #3
POWER SUPPLY
3137420
+24V 6/8A
HEAD LIGHT BOARD
3134801
FAN
22268004
41696000
(MASTER)
(SLAVED)
CONTROLLER BOARD
4157601
3509002
C1
18000UF @25V
C2
18000UF @25V
PRINTHEAD DRIVER BOARD #1
3192301
PRINTHEAD DRIVER BOARD #2
3192301
31564000
3509001
PRINTHEAD #1 (LEFT)
PRINTHEAD #2 (RIGHT)
LIGHT BAR DRIVER
41578000


NEXT ASSY
USED ON
REVISIONS
REV
DESCRIPTION
A ISSUE
B SCHEMATIC UPDATE ECR 1685
NOTE: THIS SECTION X2 FOR 16 CHANNELS
CHANNELS
RS232
IEEE
SIG REPORT
CPU BOARD
4157201
UTILITY
I/O BOARD
4157301
EXT TRIG
SYS ELY 1
REM START/STOP
RIG ANA IN
RIG TTL IN
23383000
KEY SWITCH
KEY PAD MAIN
4158401
KEY PAD (ALDO
4158301
STEPPER MOTOR
DRIVER BOARD
3822001
MOTOR
UTILITY BOARD
4157701
INC OPTION
23043824
TOF
MOTION SENSE
INTLK
DISPLAY 23684000
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
ALL SURFACES
MAT'L
FINISH
INITIALS
DATE
DWN DF
CHK
ENG
MFG
APP
ISSUED
SIMILAR TO
Astro-Med Inc.
SYSTEM SCHEMATIC
AG924
SIZE
D
41691-000
REV
B
SCALE NONE
SHEET 1 OF 1

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